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Power

DECEMBER 1957
ONE DOLLAR
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The new . . . MODERN PLANT SURVEY

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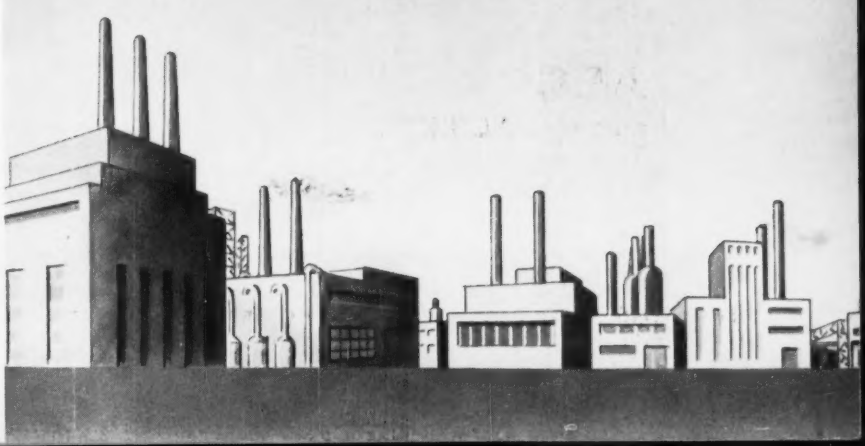

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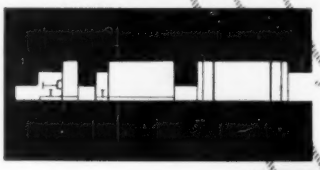
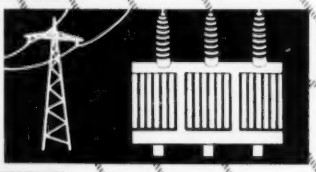
Power generation



Power transmission and distribution – Power conversion



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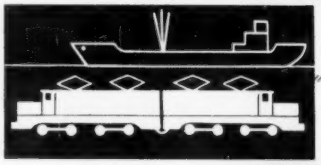
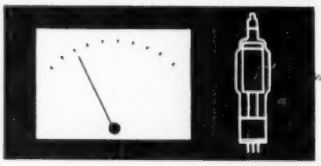
Marine engineering
Airfield equipment



Electrical equipment for industry

Electronics
Measuring – Regulating – Testing



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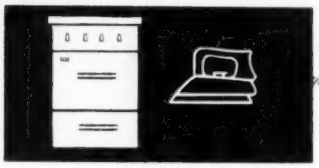

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ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT

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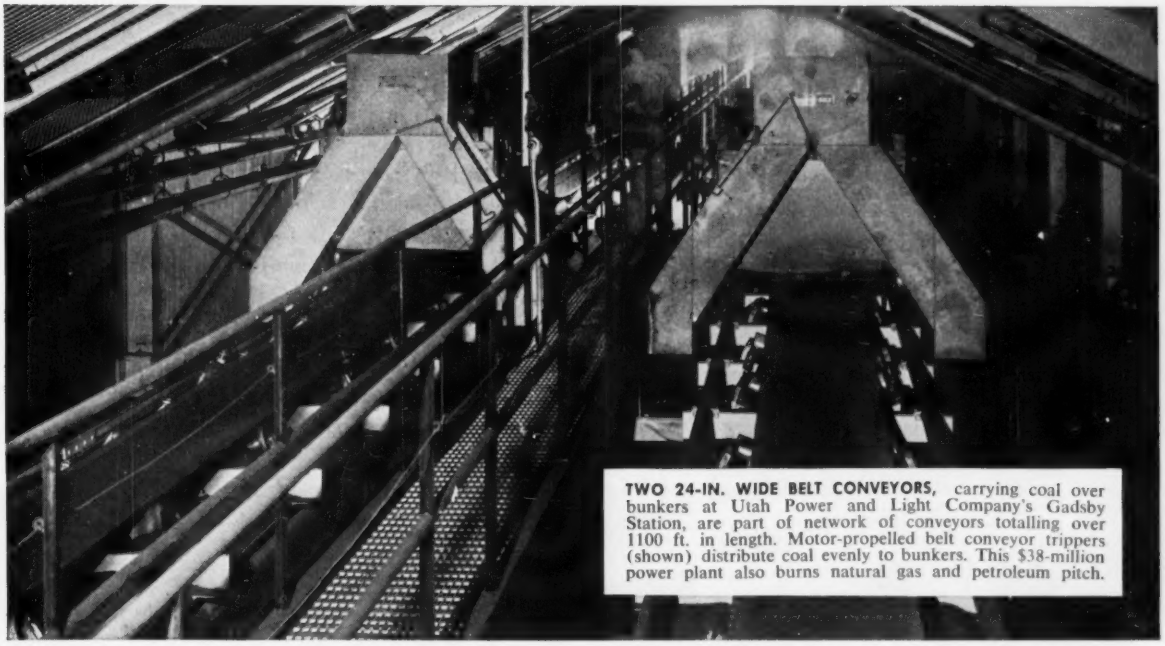
LINK-BELT coal-carrying conveyors prove

sure route to dependable power



TWO 24-IN. WIDE BELT CONVEYORS, carrying coal over bunkers at Utah Power and Light Company's Gadsby Station, are part of network of conveyors totalling over 1100 ft. in length. Motor-propelled belt conveyor trippers (shown) distribute coal evenly to bunkers. This $38-million power plant also burns natural gas and petroleum pitch.

Coal handling system at Utah Power and Light Co. can move 400 tph . . . has 100,000-ton storage capacity

GADSBY Station in Salt Lake City is one of the major power plants in the West that burns coal as an alternate fuel. Its two coal-burning boilers consume 1700 tons a day under full load. And to make sure the boilers always have an adequate and ready supply of fuel, this 241,000-kilowatt plant utilizes an efficiently integrated Link-Belt coal handling system.

Working with the Bechtel Corporation, consulting engineers, Link-Belt furnished the system to handle coal smoothly and at low per-ton cost—from railroad cars to crusher . . . to and from storage . . . to bunkers.

Whether your coal handling problems involve unloading, storing, weighing, reclaiming, elevating or feeding—Link-Belt's vast experience and complete line of equipment can work for you. Get complete details from your nearest Link-Belt office. Or write for Book 2410, containing the latest layouts and equipment for power plants, large and small.

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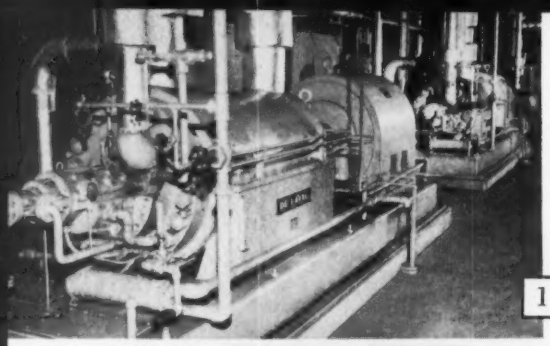

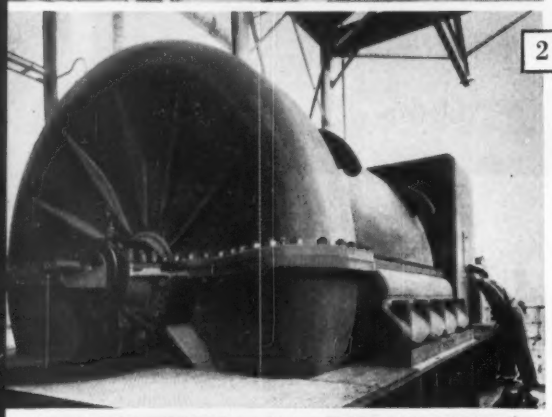

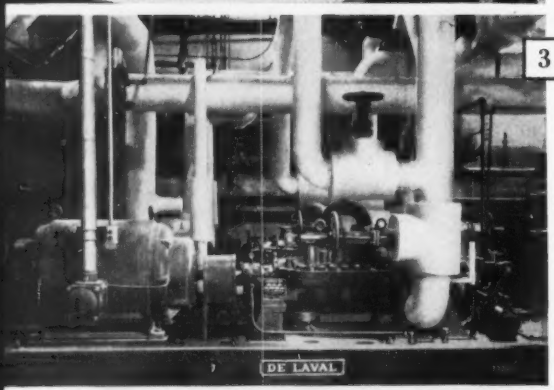

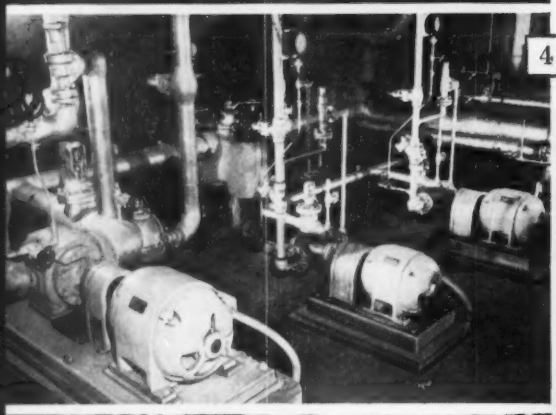

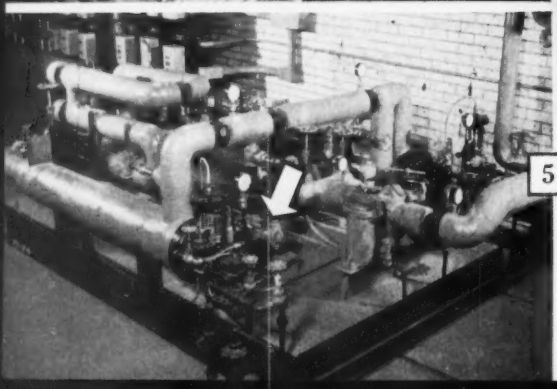

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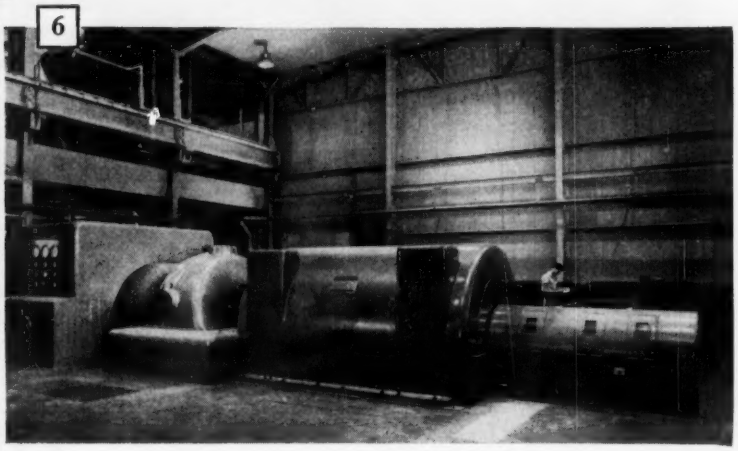

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Power

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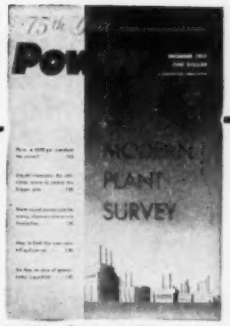

NEW CAPACITY for our ever-booming national power plant is detailed in POWER's *1957 Modern Plant Survey*. Here you can learn what's new in sizes, locations, types of equipment for industrial, central-station and hydroelectric plants of today and tomorrow. As a continuing service to the field, POWER catalogs year-by-year developments to bring power engineers abreast of today's practices, p 79.

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Next month . . .

Nuclear steam generators must be designed on the well-known principles of heat transfer with an eye to the special problems of radioactive fuels. When gas coolants are used we must wrestle with a few extra factors. All the dope is in upcoming 4-pager.

Short-circuit current potential in your electrical distribution system may be greater than your protective equipment can handle. If so, you're sitting on a time bomb. January article gives clarifying review of conventional method of short-circuit calculations, plus a simplified method that's applicable to most distribution systems.

. . . and future months

Demineralizing — a water-treatment technique that's buzzing with activity —will be theme of a "latest trends" report. Coming in February.

Nondestructive testing is subject of POWER's next special report—a 24-p package that wraps up all the latest developments in this fast-moving field. Watch for it in the March issue.

Print order this issue: 49,817

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Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in POWER.

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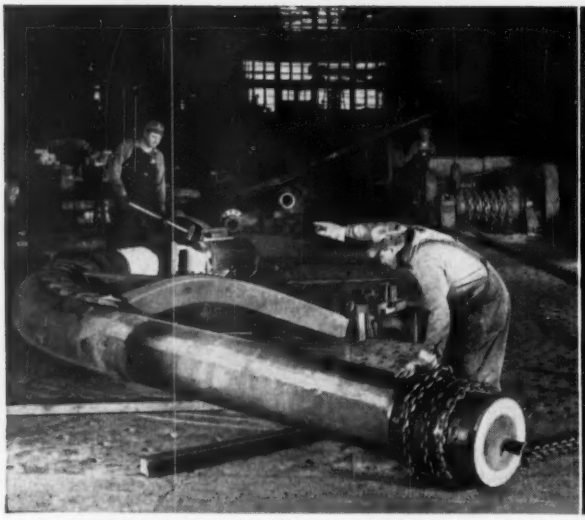
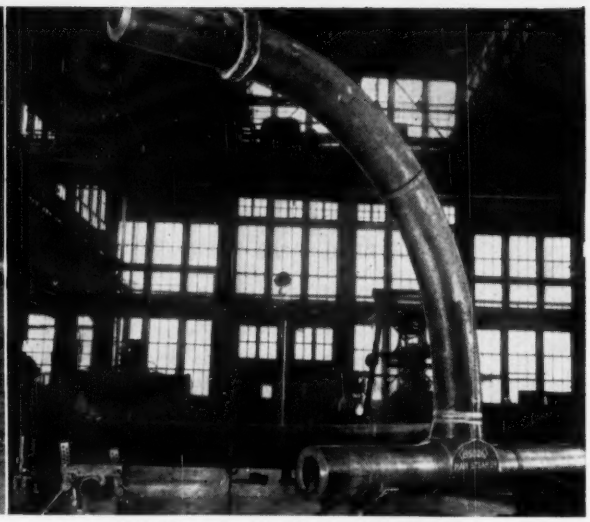
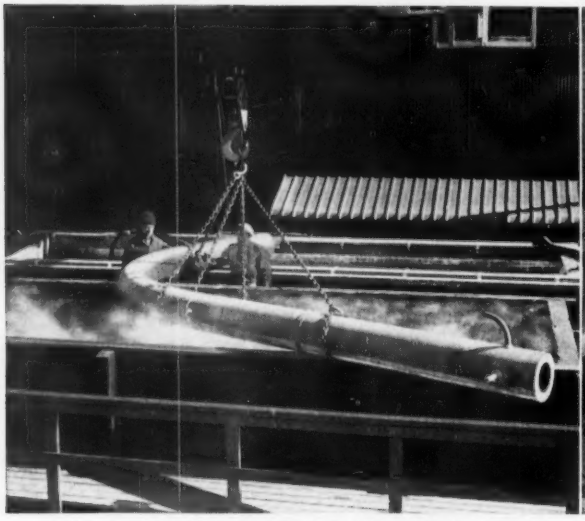


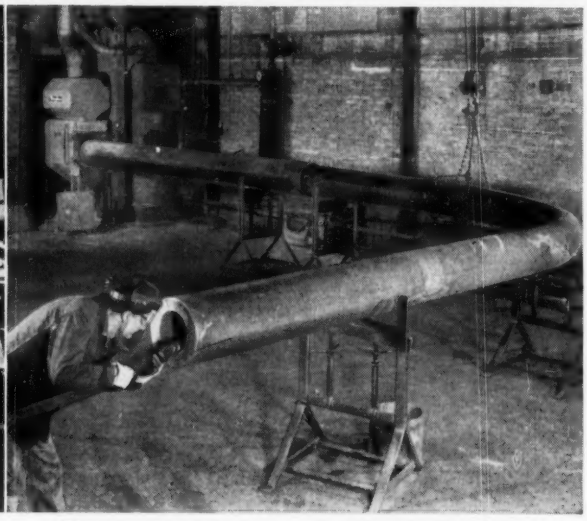
Crane's skilled shopmen bend 17¾" O.D. pipe with 3¼" wall. Pipe bend is for steam service—1970 lbs. at 1050 deg. F.



Experienced Crane welders have welded the bend (see photo 1) to header. Pipe is 2¼% chrome, 1% moly, alloy steel. Unit shown weighed 15,000 lbs.



Pipe bend fabricated by Crane is being pickled as part of cleaning procedure. Pipe is chrome-moly alloy—2.539" wall thickness; 13.578" O.D. Unit weighs 9050 lbs.



Pipe shown at left also was shot-blasted. Combining pickling and shot-blasting assures maximum interior cleanliness.

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Do your high pressure-high temperature piping specifications call for bending and fabricating pipe of greater wall thicknesses than the maximums shown in Schedule 160 thicknesses?

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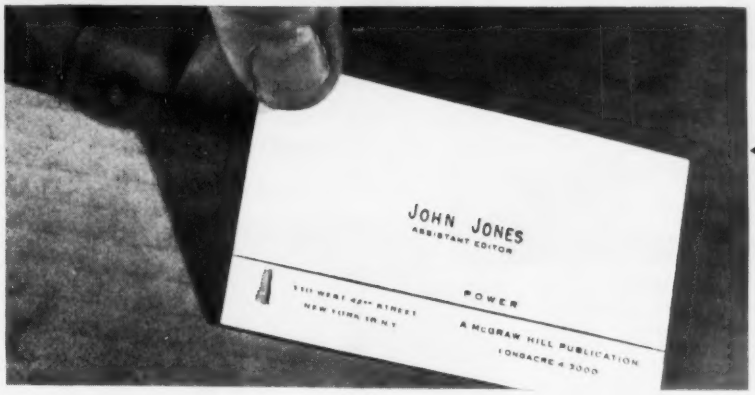

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W K PONDER — *Circulation Manager*

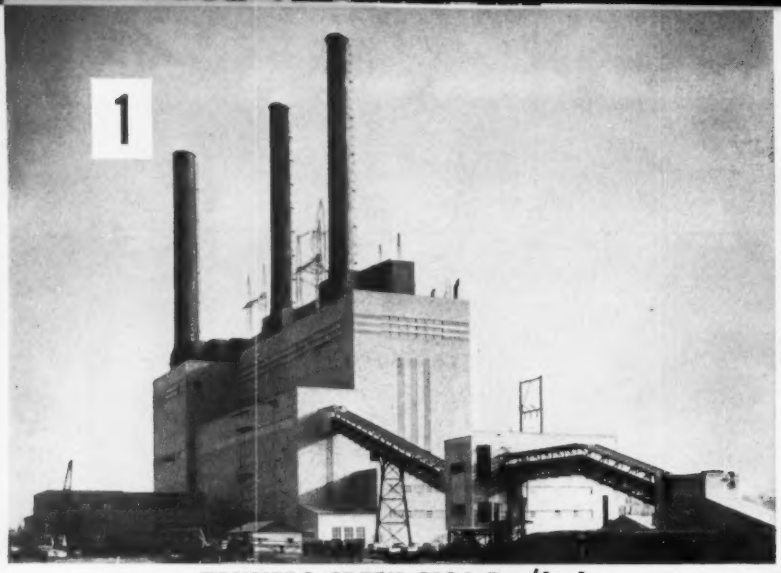
Two young engineers with a bent toward technical journalism, plus a strong spark of creative ability, will soon join POWER's expanding editorial staff. As this issue goes to press, the positions are still open. The men sought should have been schooled in either electrical or mechanical engineering and spent several years in either the design or application phases of power-service engineering.

As *Power* editors they will serve as idea fonts for themes of future articles and special reports. They may well be the first to break technical ground by spotting new and better methods. And they will report these findings through the pages of POWER—firsthand or by getting the best qualified engineer-author to do so. This won't be accomplished by sitting back in their chairs, blue pencils in hand, waiting for manuscripts to arrive at their desks.

Travel, not necessity, plays a significant part in every editor's operations. About 15% of his time is spent tracking down article leads, attending and taking active part in engineering society meetings, visiting readers at their plants. Travel is the only practical way to keep abreast of current technical problems, to learn who is solving them and how they are going about it. So, wherever engineers meet to swap notes or discuss new techniques, you'll find a POWER editor.

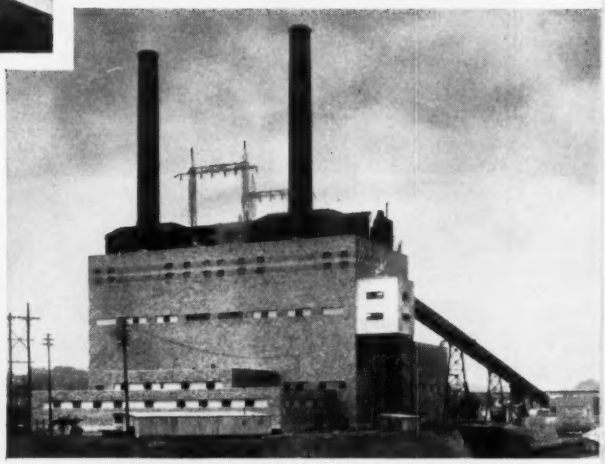
Publishing experience shows that clear hard-hitting writing can be taught, as evidenced by the fact that most POWER editors acquired their writing skill on the job. However, many of them displayed an earlier interest in writing as school-paper staffers or as engineer-authors. The new men selected will have ample opportunity to learn how a top editorial staff gathers engineering info, organizes it for maximum usefulness, presents it in a clear easy-to-grasp style. They'll work closely with POWER's seasoned editors to obtain this journalistic know-how.

Interested? If the above summary appeals to you, not merely as a job but as a way of life; if you have the necessary engineering savvy plus journalistic leanings, send your resumé now to L N Rowley, Editor.

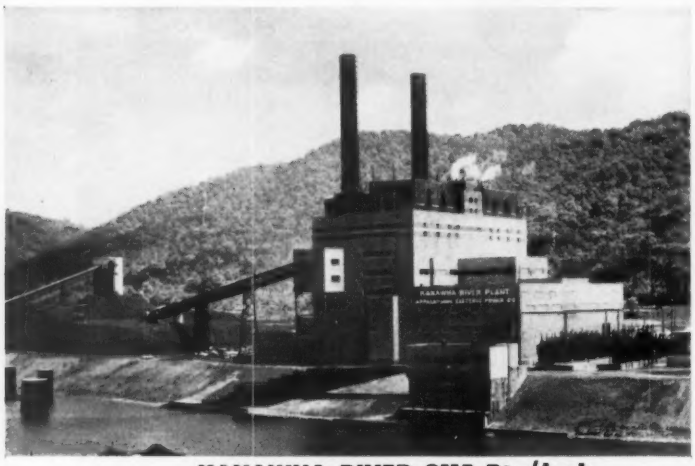


TANNERS CREEK 9106 Btu/kwhr
Indiana & Michigan Electric Co. on the American Gas and Electric System
Three B&W Pressure-Fired Radiant Reheat Boilers

MOST EFFICIENT HEAT RATES IN THE POWER INDUSTRY

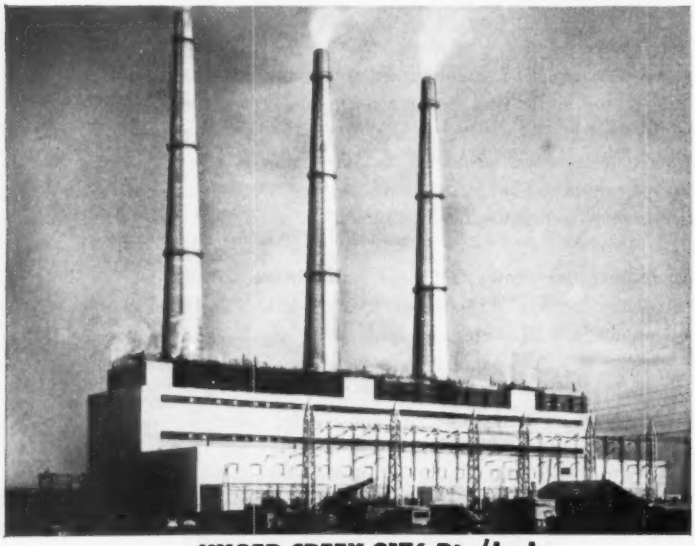


MUSKINGUM RIVER 9176 Btu/kwhr
Ohio Power Co. on the American Gas and Electric System
Two B&W Pressure-Fired Open-Pass Reheat Boilers



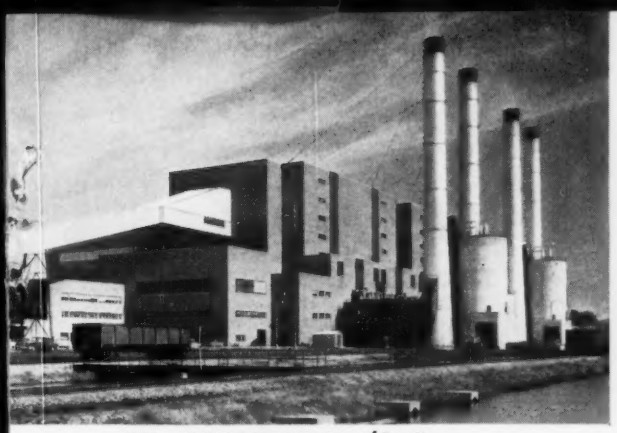
KANAWHA RIVER 9115 Btu/kwhr
Appalachian Electric Power Co. on the American Gas and Electric System
Two B&W Pressure-Fired Radiant Reheat Boilers

CLIFTY CREEK 9200 Btu/kwhr
Indiana-Kentucky Electric Corporation†
Six B&W Pressure-Fired Open-Pass Reheat Boilers

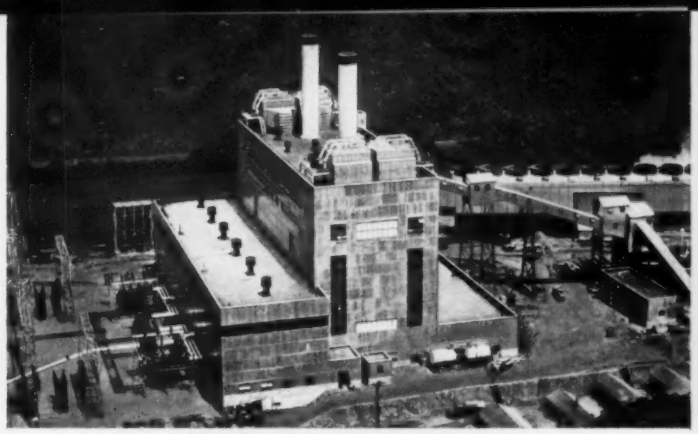


KYGER CREEK 9176 Btu/kwhr
Ohio Valley Electric Corporation†
Five B&W Pressure-Fired Open-Pass Reheat Boilers

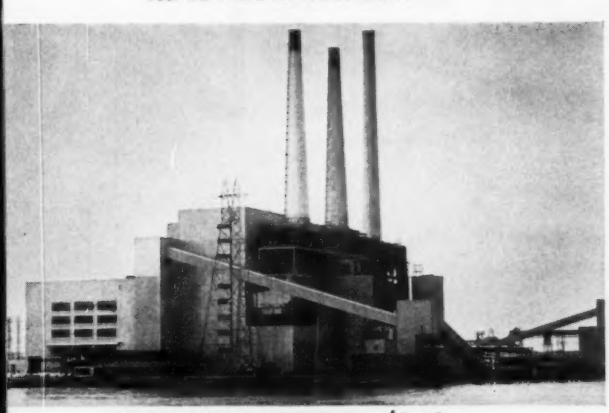
JOHN SEVIER 9221 Btu/kwhr
Tennessee Valley Authority



ST. CLAIR 9200 Btu/kwhr
Detroit Edison Co.
Four B&W Radiant Reheat Boilers



SHAWVILLE 9241 Btu/kwhr
Pennsylvania Electric Co.
Two B&W Radiant Reheat Boilers



RIVER ROUGE 9210 Btu/kwhr
Detroit Edison Co.
One B&W Radiant Reheat Boiler

BAY SHORE 9282 Btu/kwhr
Toledo Edison Company
One B&W Radiant Reheat Boiler

B&W Engineering Developments Pay Off in Power Plant Efficiency

Nine Out of Nation's Top Ten Have B&W Boilers

Here are the ten most efficient power plants in the United States in 1956 as reported by the Federal Power Commission. Their achievement reflects the signal success of the power industry in keeping electricity America's best bargain despite rising fuel and other costs.

A major investment in engineering research and development has made possible these great strides in power plant efficiency. Six years ago only two plants operated under 10,000 Btu per net kwhr. In 1956 there were no less than 47. In addition a great many new units incorporated in older plants are now operating at these high efficiencies. It is significant that nine out of the nation's top ten plants in terms of efficiency are equipped with B&W boilers.

B&W's role in this vital industry has been a crucial one, covering nearly a century of boiler engineering, design and fabrication. Today, millions of dollars are being invested in major B&W engineering developments—such as the Universal Pressure Boiler, utilization of low grade fuels, basic metallurgical research for high temperatures, and nuclear energy—all to help America's utilities continue to supply abundant, economical, reliable electricity. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-877-CS

† Ohio Valley Electric Corporation and its subsidiary, Indiana-Kentucky Electric Corporation, sponsored by these companies:

Appalachian Electric Power Company* • The Cincinnati Gas & Electric Company Columbus and Southern Ohio Electric Company • The Dayton Power and Light Company • Indiana & Michigan Electric Company* • Kentucky Utilities Company • Louisville Gas and Electric Company • Monongahela Power Company** Ohio Edison Company • Ohio Power Company* • Pennsylvania Power Company*** • The Potomac Edison Company** • Southern Indiana Gas and Electric Company • The Toledo Edison Company • West Penn Power Company**

* Subsidiary of American Gas and Electric Co. ** Subsidiary of The West Penn Electric Co. *** Subsidiary of Ohio Edison Co.

BABCOCK & WILCOX

BOILER DIVISION

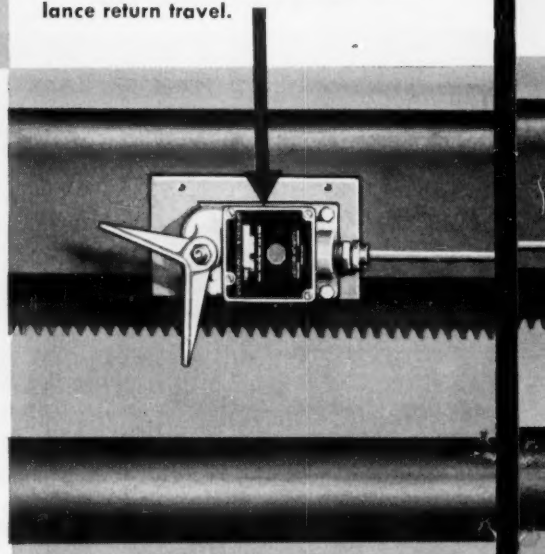
ELECTRIC POWER and CONTROL TERMINAL FACILITIES

ANOTHER

Simple, convenient, rugged . . . the electric power and control center of the new Series 300 IK contributes substantially to the dependable, trouble-free operation of this blower. Terminal facilities and the control assembly are concentrated in a cast aluminum box at the drive end. No internal field wiring is required; the blower is completely wired at the factory. The control is linked directly to lance travel and is governed by two durable snap switches . . . actuated by a cam on the lance carriage.

Additional important features of the new Series 300 IK are listed in the panel below. Check them and you will understand why this blower is establishing a new standard of efficiency, economy and dependability in cleaning those heating surfaces that require a long retracting blower. For further information about the new Series 300 IK, ask the nearest Diamond office or write directly to Lancaster for Bulletin 2111U.

Inboard Travel Limit Switch (cover removed). Switch near other end limits lance return travel.



Control for air operation is also simple, compact, accessible and dependable.

Other Advantages of Series 300 IK Blowers

- Backbone and Protective Cover
- Front End Single-Motor Drive
- Nozzle-Sweep-Every-Inch Cleaning Pattern
- Improved "Type A" Nozzle
- Positive Gear Carriage Drive
- Poppet Valve with Adjustable Pressure Control
- Positive Mechanically Operated Valve
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other Blower gives you ALL THESE ADVANTAGES

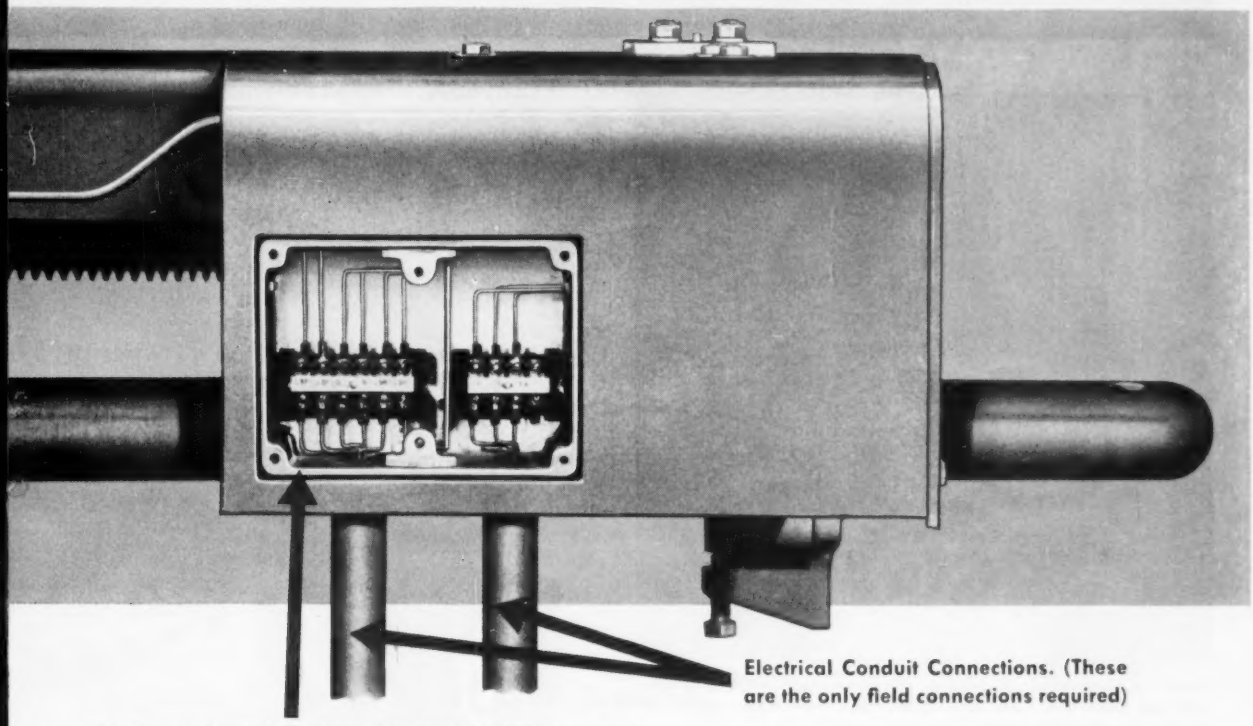
Diamond

DIAMOND POWER

IMPORTANT FEATURE

of the new Diamond series 300 IK

LONG RETRACTING BLOWER



Electrical Conduit Connections. (These are the only field connections required)

Motor and Control Electrical Terminal Facilities centered in weather-resistant enclosure at drive end for improved accessibility and protection. (cover removed)

New Series 300 IK Long Retracting Blower.

"You Clean Boilers Better and at lower Cost with Diamond Blowers"

7703

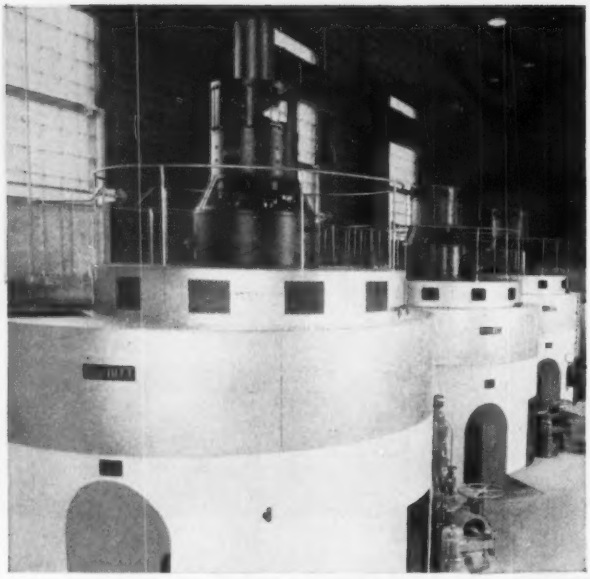
SPECIALTY CORP. LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

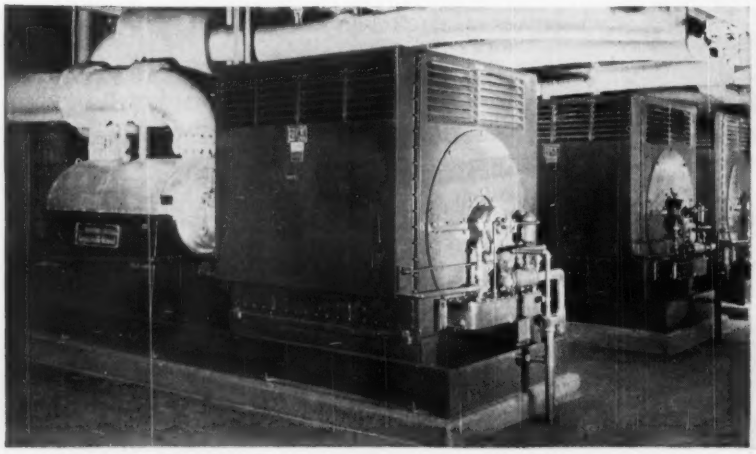
Once Again . . .

ELLIOTT

equipment was selected

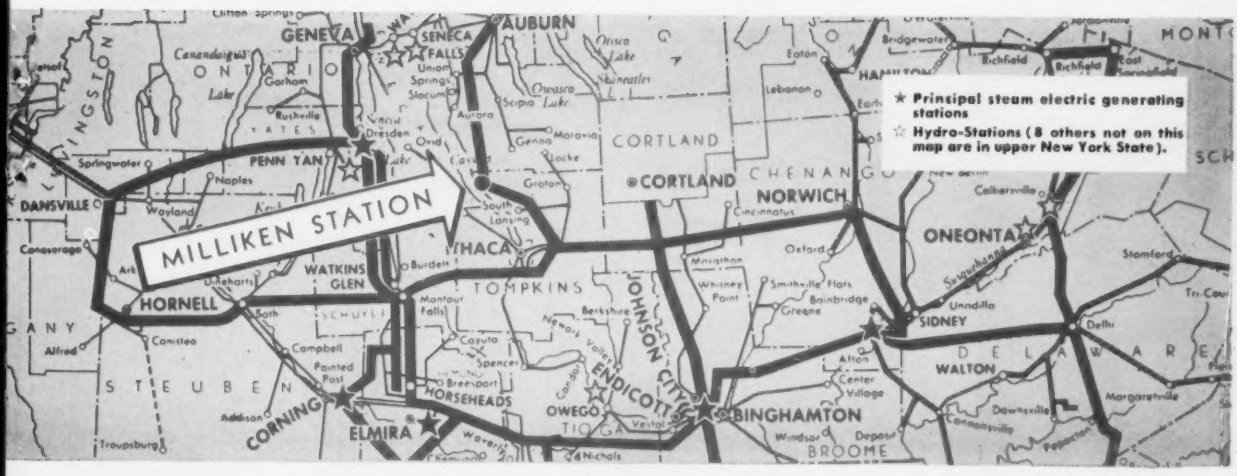


Three Elliott hydraulic turbine-driven generators—one 8750 kva, and two 5000 kva—are serving the High Falls Hydro Station of the New York State Electric and Gas system.



The two Elliott 350-hp, 300-rpm vertical induction motors, seen above, drive the circulating pumps handling lake water at the Milliken Station.

Three Elliott 2000-hp, two-pole "super-quiet" induction motors, left, are driving the Milliken Station boiler-feed pumps.



Elliott Motors, Motor-Generators, Deaerating Heaters, Condensers and Twin Strainers have been used in various stations of New York State Electric & Gas System for many years.

Now, Elliott equipment is serving the Milliken Station

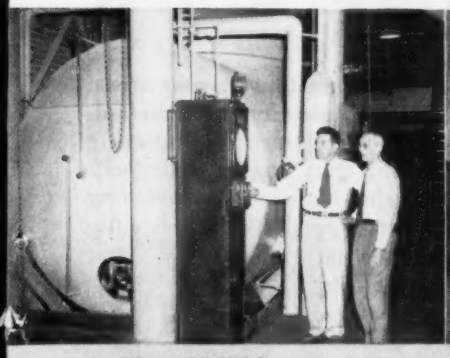
Back in 1852, eight men subscribed $75,000 as initial capital to incorporate a gas light company in Ithaca, New York. Today, as the New York State Electric & Gas Corporation, this aggressive company has more than 15,000 stockholders and a capital investment of over $330,000,000. Before the new Milliken Station was added last year, there were already five principal steam electric generating stations and 13 hydro-stations and the company was serving 35 per cent of the New York State area.

Selecting dependable steam and electrical equipment for an expanding organization of this type is vitally important. In this case, Elliott products previously installed in the company's various stations had already proven their dependability. Once again Elliott equipment was selected. The same thing has happened all over the country—again and again, *consistent, trouble-free performance has led to repeat orders.* For descriptive literature, call your nearest Elliott District Office or write Elliott Company, Jeannette, Pa.

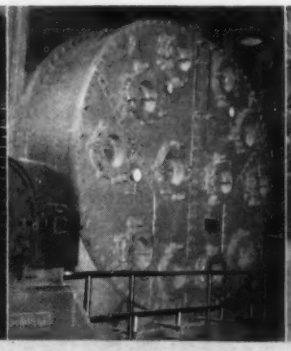
ELLIOTT Company

Steam Turbines• Motors• Generators• Deareating Heaters• Ejectors• Condensers• Centrifugal Compressors• Turbochargers• Tube Cleaners• Strainers

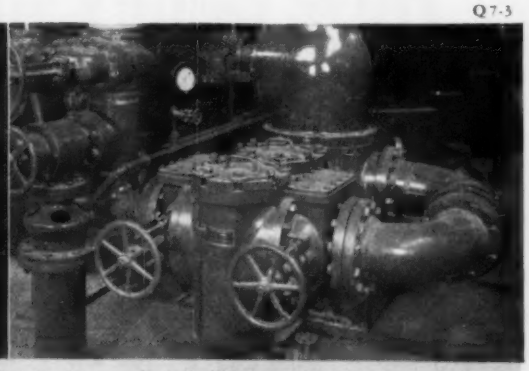
Q7-3



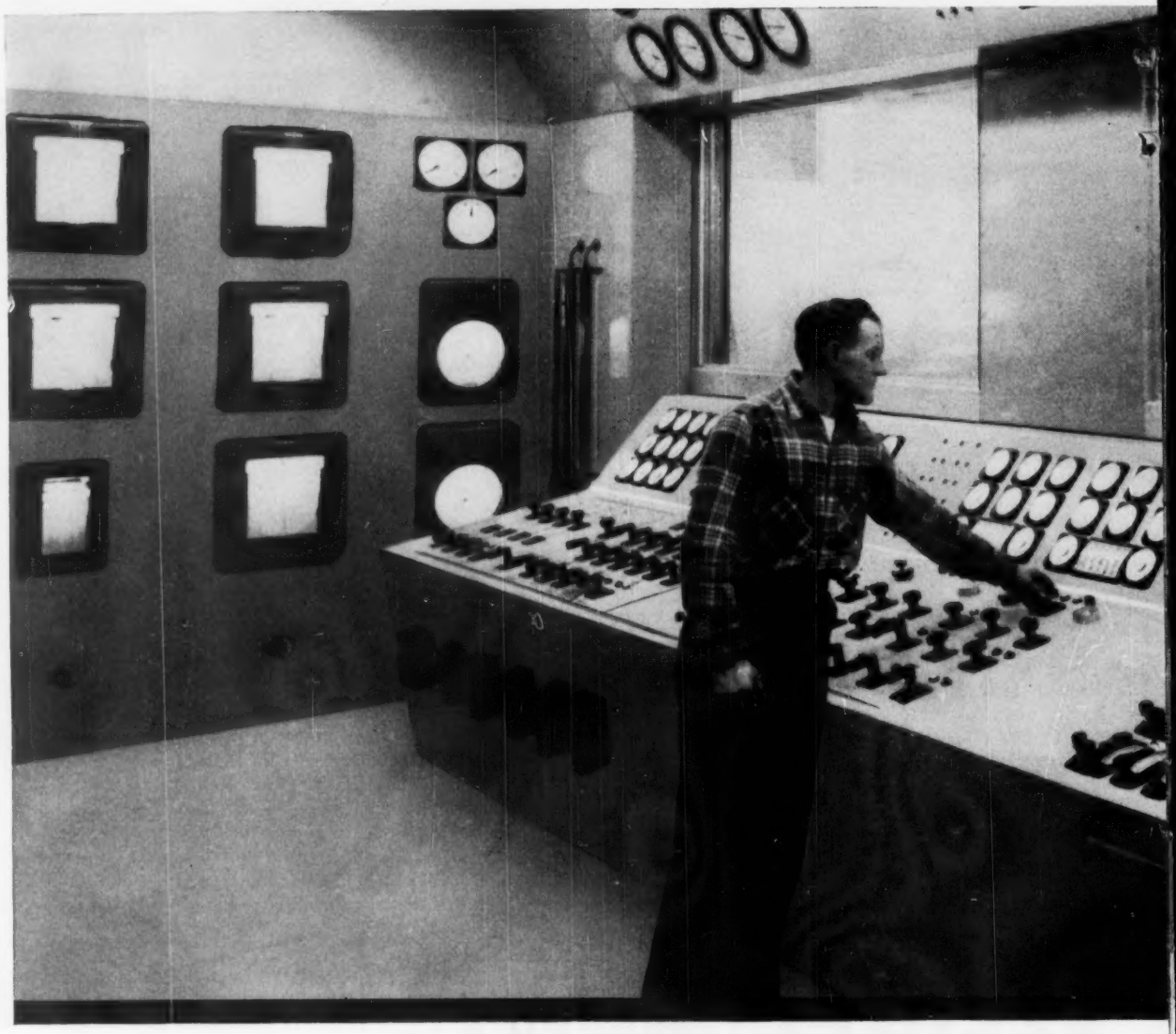
An Elliott 210,000-lb-per-hr deaerating heater in the Greenridge Station, which has a vertical heater mounted on top of a horizontal storage tank.



An Elliott 27,000-sq ft divided water-box surface condenser, seen above, serves the No. 7 turbine in the Goudey Station.



Installed in the suction line to a gasoline-engine-driven fire pump at Milliken is this Elliott 8-in. twin strainer.



How Bailey helps you get a new

The thrill of putting a new station "on-the-line" can be marred if steam plant meters and controls don't work smoothly, efficiently. You are a lot surer of a fast, safe start and dependable operation for a long time when you specify Bailey Meters and Controls. They are keys to peak efficiency and low operating costs.

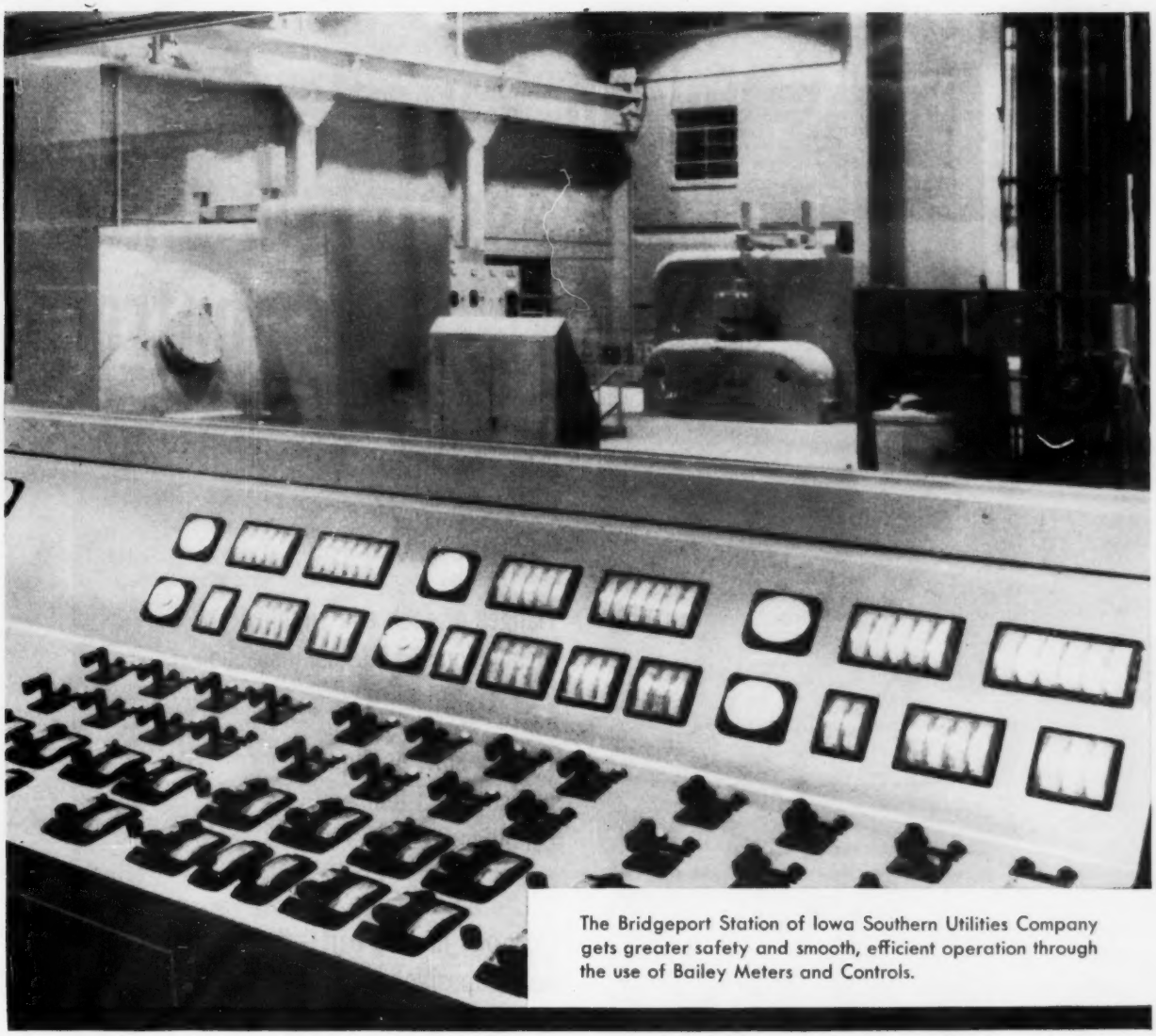
Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men



The Bridgeport Station of Iowa Southern Utilities Company gets greater safety and smooth, efficient operation through the use of Bailey Meters and Controls.

station off to a fast, safe start

who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A131-2

BAILEY METERS

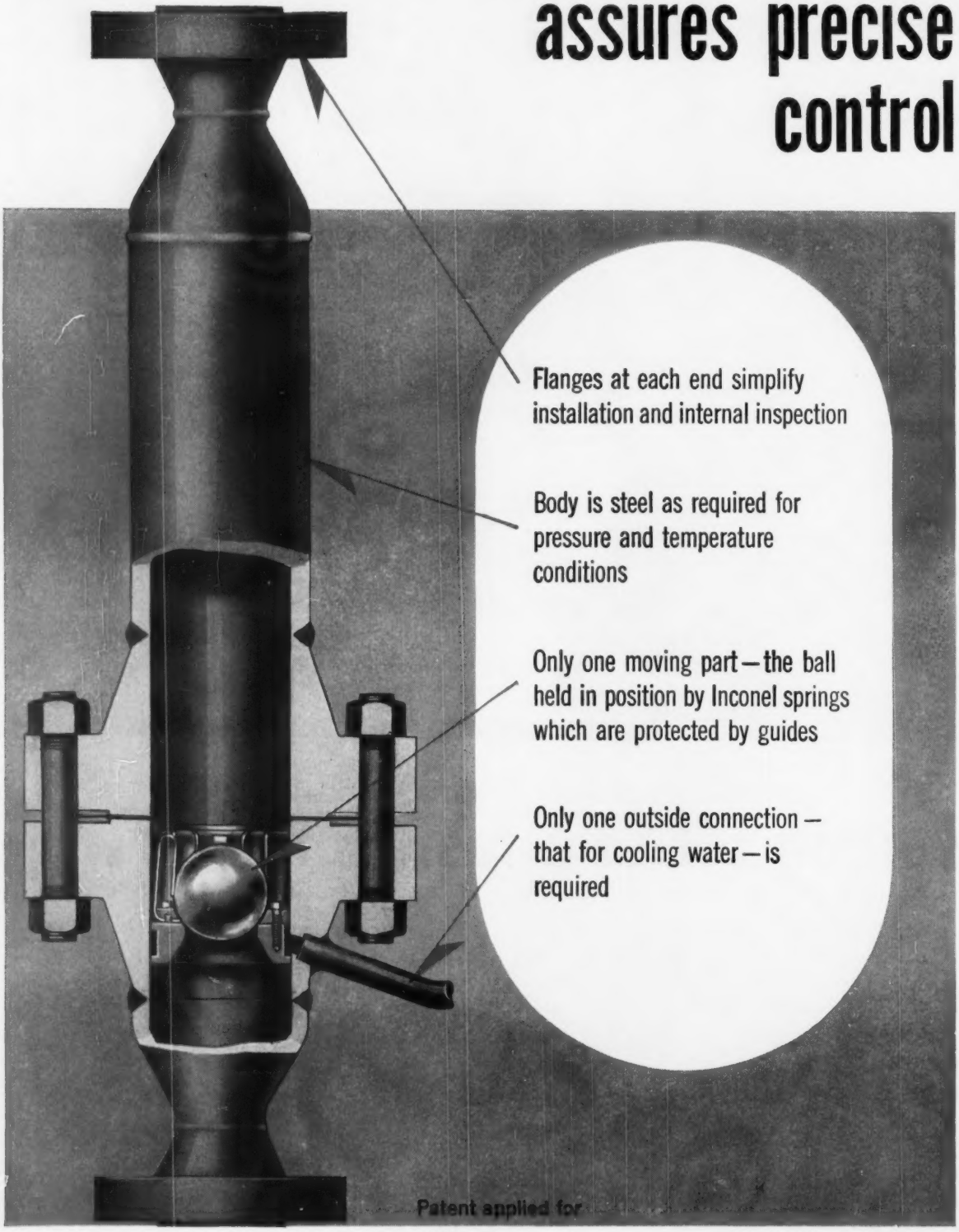
Instruments and controls for power and process

BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

New—Copes-Vulcan Variable-Orifice assures precise control


Flanges at each end simplify installation and internal inspection
Body is steel as required for pressure and temperature conditions
Only one moving part—the ball held in position by Inconel springs which are protected by guides
Only one outside connection—that for cooling water—is required
Patent applied for

Desuperheater temperature

Here is a unique desuperheating approach for close control of reduced steam temperatures, regardless of load variations. Using a weighted steel ball for controlling the orifice opening, this new Copes-Vulcan Variable-Orifice Desuperheater speeds the intimate mixing of cooling water and steam. Vaporization is so complete that reduced steam temperature can be held constant only 20 feet downstream from the desuperheater outlet — even over a 50-to-1 load range.

Advance design means:

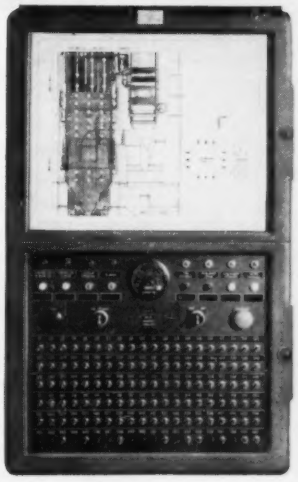
- *No long run of piping needed to mix fluids*
- *No excess water to be removed from the steam*
- *No atomizing steam required*
- *No spray nozzle or glands*

Incoming steam lifts the ball an amount determined by the weight of the ball and the amount of steam flow. This assures a constant pressure drop of approximately 3 psig at all rates of flow, making possible precise control over extreme load ranges. Cooling water is controlled by a Copes-Vulcan valve responsive to the temperature controller.

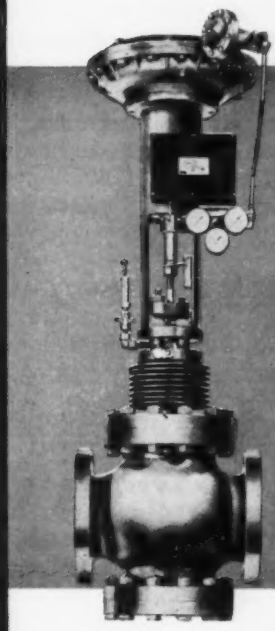
The Variable-Orifice Desuperheater is one of a complete line — each type engineered to meet particular operating conditions. Copes-Vulcan designs each station to meet your individual requirements.

COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

C-V NEWS NOTES



On order for a 5000-psig boiler in an Eastern utility station, this Vulcan Selective-Sequence Model SSC-120 control panel can preset four different or identical sequences of up to 120 soot blowers. 60-station Model SSC-60 control also available.



New Copes-Vulcan diaphragm-operated Type CV-D valve provides control service for applications calling for superior accuracy and dependability. Reverse or direct-acting. Sizes up to 14-inch at unlimited pressures. Write for Bulletin 1027.

New bulletin on Variable-Orifice Desuperheater gives complete description with specifications. Schematic drawings in color show typical installation and explain operating principle. For details, write for Bulletin 1037.

THE KVP COMPANY
Manufacturers and Converters of Paper
KALAMAZOO, MICHIGAN TEL. FIreside 3-2581

September 30, 1957

Mr. O. A. Soderberg
District Manager
Combustion Engineering, Inc.
1537 Book Building
Detroit 26, Michigan

Dear Al:

Nineteen months ago we placed boiler No. 9 in service. Since No. 9 is a C-E boiler, we thought you might be interested in the following information.

The paper industry is highly competitive and a difference of a fraction of a cent per pound of paper often means the difference between selling and not selling a customer. When it is considered that 11% of the manufacturing cost of our paper is power cost, it can be seen that any reduction in power cost has a real influence on the cost of the paper produced.

The installation of No. 9 boiler has contributed to reducing power costs in several ways.

(a) INCREASED EFFICIENCY

Boiler No. 9 replaced three existing boilers having an average efficiency of 78% with one boiler having an efficiency of 87.2%.

(b) REDUCTION IN FUEL COST

The three boilers replaced required coal having an ash fusion temperature above 2500 degrees F., whereas in No. 9 furnace we have burned, with no difficulty, coal having an ash fusion of 2100 degrees F. The ability of the boiler to use such coals opens up sources of coal supply hitherto unsuitable for our use, but which are now economically attractive.

(c) LOW MAINTENANCE AND HIGH AVAILABILITY

Maintenance costs to date have been very low. The boiler has been in operation nineteen months and the only outage for repairs occurred

Plants at KALAMAZOO, MICHIGAN
DEVON, PENNSYLVANIA
HOUSTON, TEXAS
STURGIS, MICHIGAN

ASSOCIATED COMPANIES of the KALAMAZOO VEGETABLE PARCHMENT COMPANY
THE KVP COMPANY LIMITED, Espanola, Ontario
APPLEFORD PAPER PRODUCTS LIMITED, Hamilton, Ontario and Montreal, Quebec

shortly after the unit was put in operation, when soot blower misalignment caused cutting of several tubes. Fortunately, this occurred at the end of the week when the boiler was taken off the line for a scheduled outage and our own maintenance crew made temporary repairs by seal welding the cuts. Shortly after, Combustion, at their own expense, replaced sections in six damaged tubes during a scheduled Sunday outage. This work required about eight hours and no production time was lost.

Each of the two pulverizers has handled over 50,000 tons of coal without maintenance other than minor adjustments.

(d) LIBERAL BOILER DESIGN

The ability of the boiler to handle sudden increases in load was demonstrated when it was called upon to pick up the load of one of the other boilers which was tripped off the line due to mechanical equipment failure. At that time No. 9 boiler output increased from 175,000 lbs. per hour to 230,000 lbs. per hour without difficulty and without interruption to manufacturing production. This load was 30% above the maximum continuous rating for which the boiler was designed. It may be of further interest to you to know that the liberal design of the boiler permits it to carry a load in excess of the above, the limiting factor being the capacity of the feed water valve.

As you may gather from the above, we are greatly pleased with this installation.

Sincerely yours

THE KVP COMPANY

Ed

Edward A. Wade
Project Engineer

EAW:ss

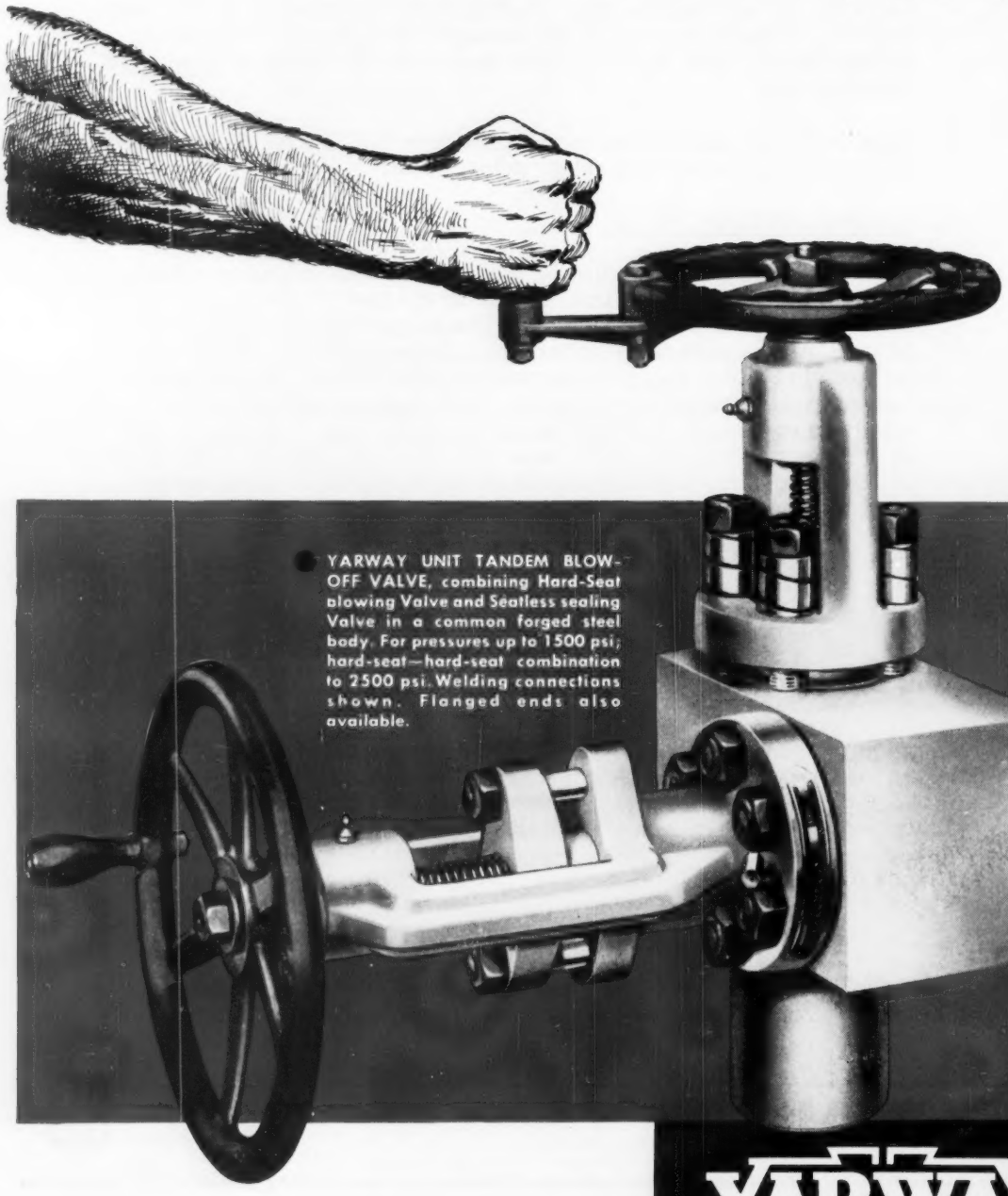
COMBUSTION ENGINEERING, INC., Combustion Engineering Building, 200 Madison Avenue, New York, N. Y.

C-E

C-134

All Types of Steam Generating, Fuel Burning and Related Equipment; Nuclear Reactors; Paper Mill Equipment; Pulverizers; Flash Drying Equipment; Pressure Vessels; Soil Pipe

rugged ... for



YARWAY UNIT TANDEM BLOW-OFF VALVE, combining Hard-Seat blowing Valve and Seatless sealing Valve in a common forged steel body. For pressures up to 1500 psi; hard-seat—hard-seat combination to 2500 psi. Welding connections shown. Flanged ends also available.

YARWAY®

rugged blow-down service

YARWAY UNIT TANDEM BLOW-OFF VALVES

When boiler pressures are high you may not "blow-down" very often, but, man, when you do, you're glad those blow-off valves are rugged YARWAY Unit Tandems!

More than 80% of high pressure boiler plants are equipped with YARWAY *Blow-Off Valves,* and there's ample reason.

YARWAYS are strong, heavy-duty valves giving the important extra dependability needed for the severe combination of high pressures (hence high velocities), acid cleaning, and abrasion caused by precipitated solids.

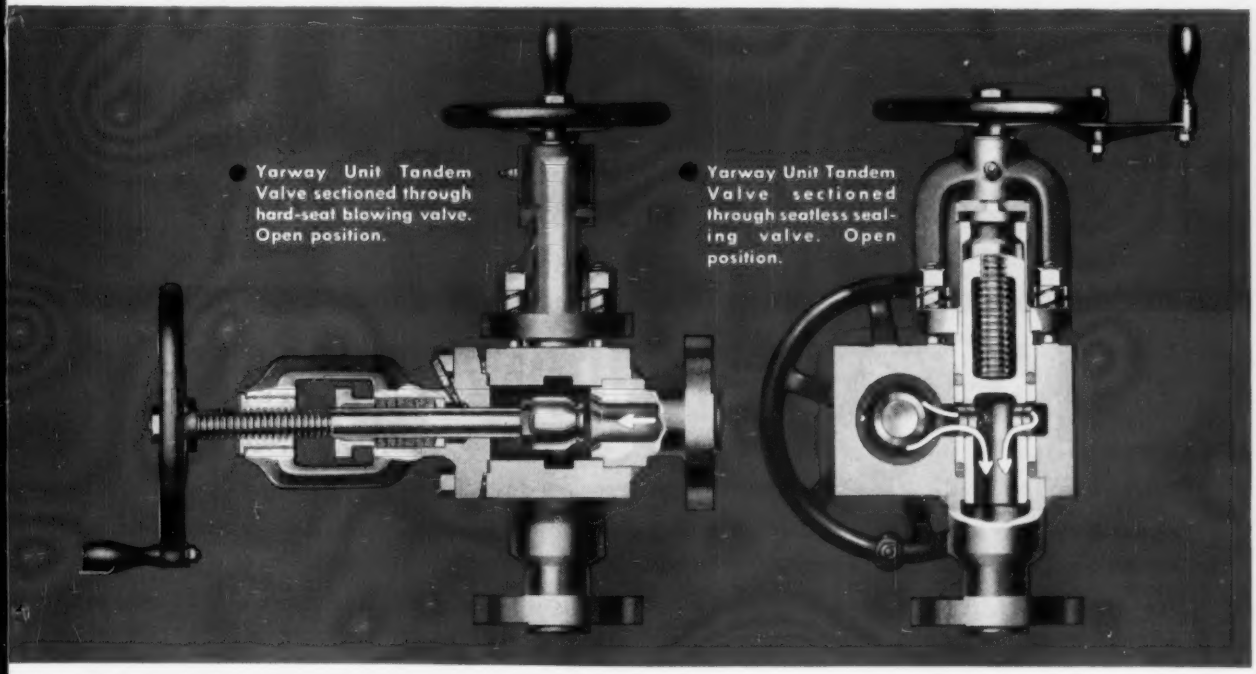
YARWAY Blow-Off Valves also are relied upon to keep boiler level within desirable limits during quick starts of high pressure boilers.

Specify YARWAYS—to protect *your* boilers. Write for Bulletin B-434.

YARNALL-WARING COMPANY

100 Mermaid Ave., Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES



● Yarway Unit Tandem Valve sectioned through hard-seat blowing valve. Open position.

● Yarway Unit Tandem Valve sectioned through seatless sealing valve. Open position.

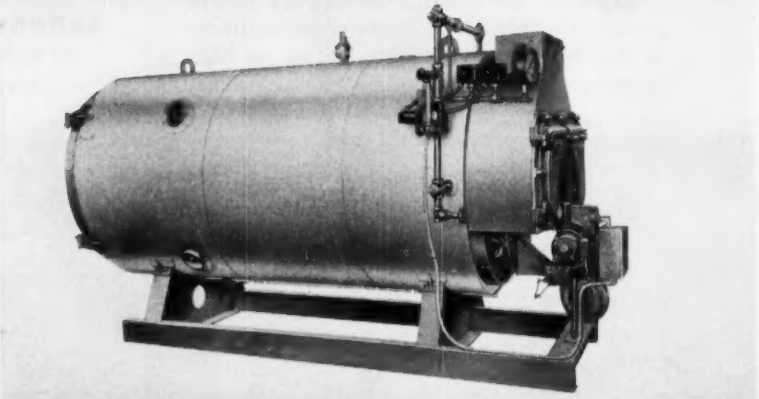
— blow-off valves

NEW!

18 TO 92 HORSEPOWER

FORCED-DRAFT

NEW 606,000 TO 3,060,000 BTUH CAPACITIES: Forced-draft package teams low pressure Kewanee Scottie Jr. Boiler with Iron-Fireman Micro-Mist Oil Burner. Exclusive burner principle completely atomizes and carburets No. 5 or lighter fuel oil before combustion.



KEWANEE®-IRON FIREMAN

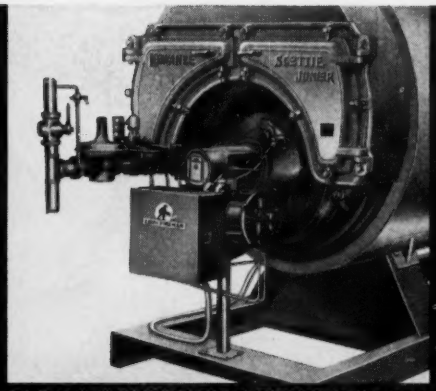
Now . . . 8 popular sizes are available in both high pressure and low pressure models.

Forced-draft firing keeps combustion air supply constant, regardless of location or atmospheric conditions. Vent pipe only is needed—eliminating added cost and unsightliness of a stack.

Fuel flexibility is offered by proved burners built on exclusive principles to completely carburet either light or heavy oils. Gas and gas-oil combination units are also available.

Kewanee factory-assembles the entire unit before shipping. Boiler is fitted with burner and controls at factory. Fire-tested if desired. Package is shipped complete—or if job conditions require, the burner may be field mounted at a later date.

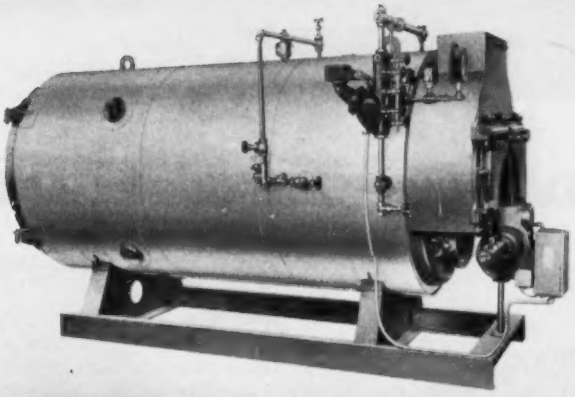
The coupon at right brings complete information. Mail it today to your nearby Kewanee Man, or to: AMERICAN-STANDARD, KEWANEE BOILER DIVISION, 101 Franklin Street, Kewanee, Illinois.

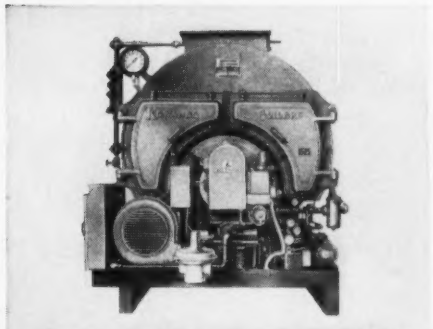


GAS-OIL COMBINATION FIRING in the new Kewanee-Iron Fireman package series is provided by the Iron Fireman Model C-240-GO Combination Gas-Oil Burner, with simple valve control for fuel changeover.

PACKAGE UNITS

NEW 18 TO 92 HP CAPACITIES: Forced-draft package combines all-welded high pressure Kewanee Scottie Jr. Boiler with matching Iron-Fireman C-240 high pressure Oil Burner—with exclusive Whirl-Blast combustion—for No. 2 oil or lighter. Provides 125-150 swp...high temperature water above 250° F.





OTHER LARGER KEWANEE-IRON FIREMAN FORCED-DRAFT BOILER-BURNER UNITS range up to 651 hp for high pressure . . . 21,855,000 Btuh for low pressure. For No. 6 or lighter fuel oil, gas and gas-oil combination firing.

American-Standard
KEWANEE BOILER DIVISION
101 Franklin Street • Kewanee, Illinois

Please supply literature on the following Kewanee-Iron Fireman Forced-Draft Package Units:

- ☐ low pressure
- ☐ high pressure
- ☐ new 18 to 92 h.p. units only
- ☐ all capacities

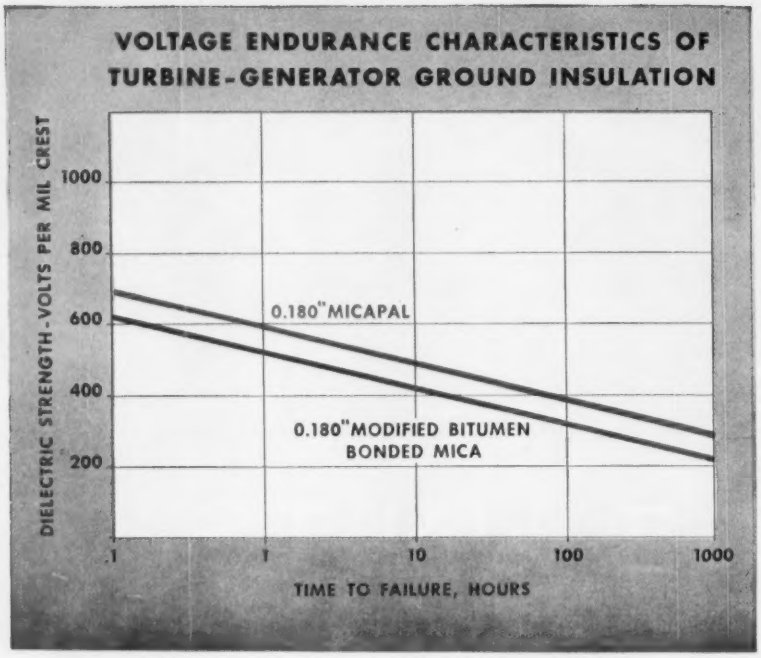
Name_____

Firm_____

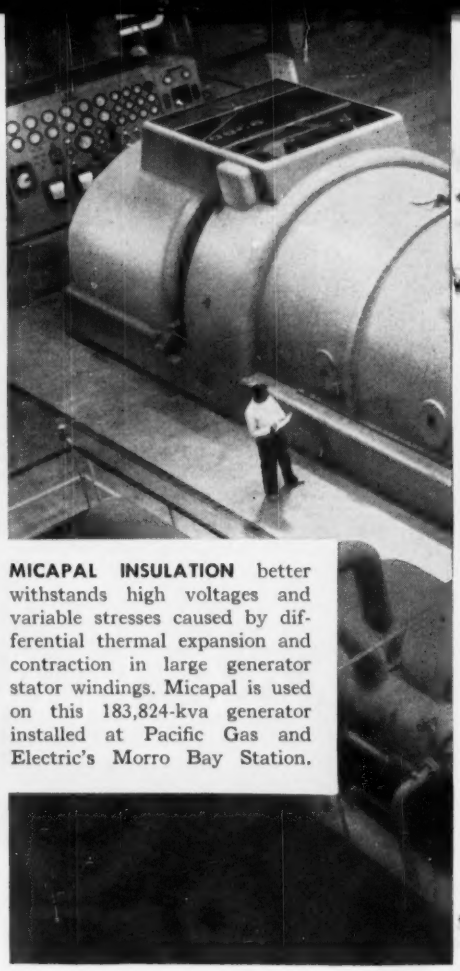
Street_____

City_____ State_____

AMERICAN-Standard
KEWANEE BOILER DIVISION

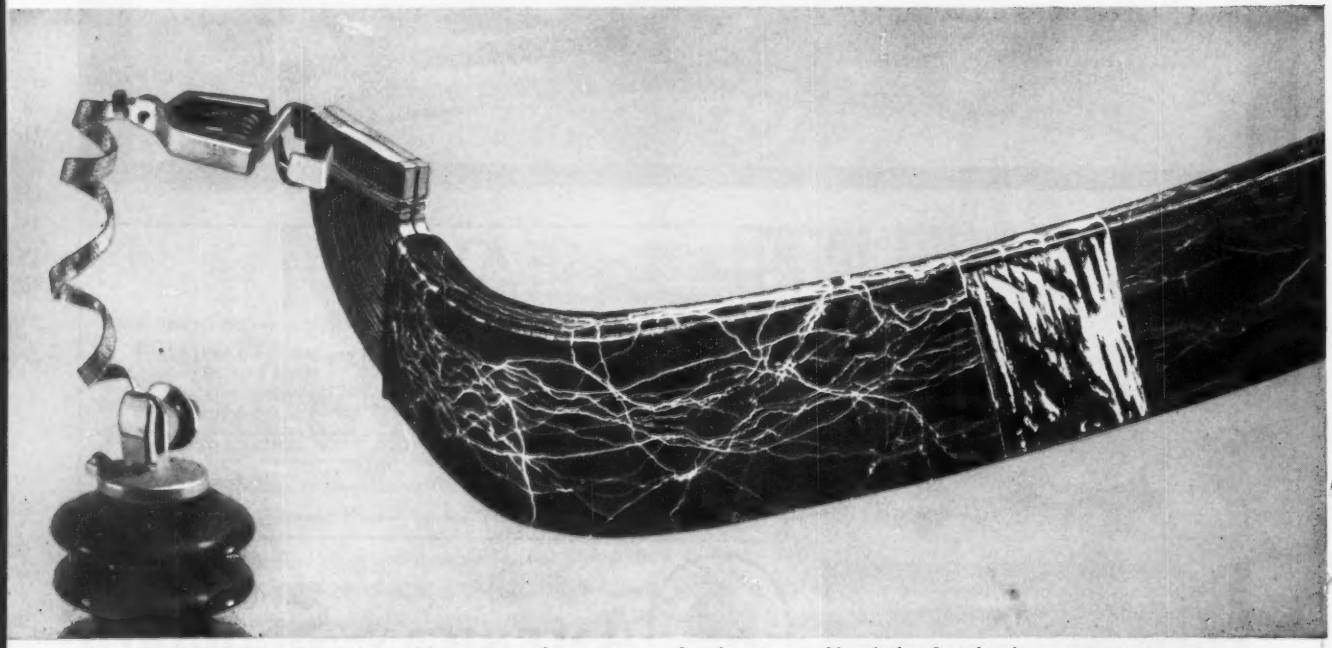


SIGNIFICANT IMPROVEMENT is noted in voltage endurance obtained for any duration of voltage application on Micapal compared to presently accepted generator insulating material. This improved voltage endurance increases long-term turbine-generator availability.

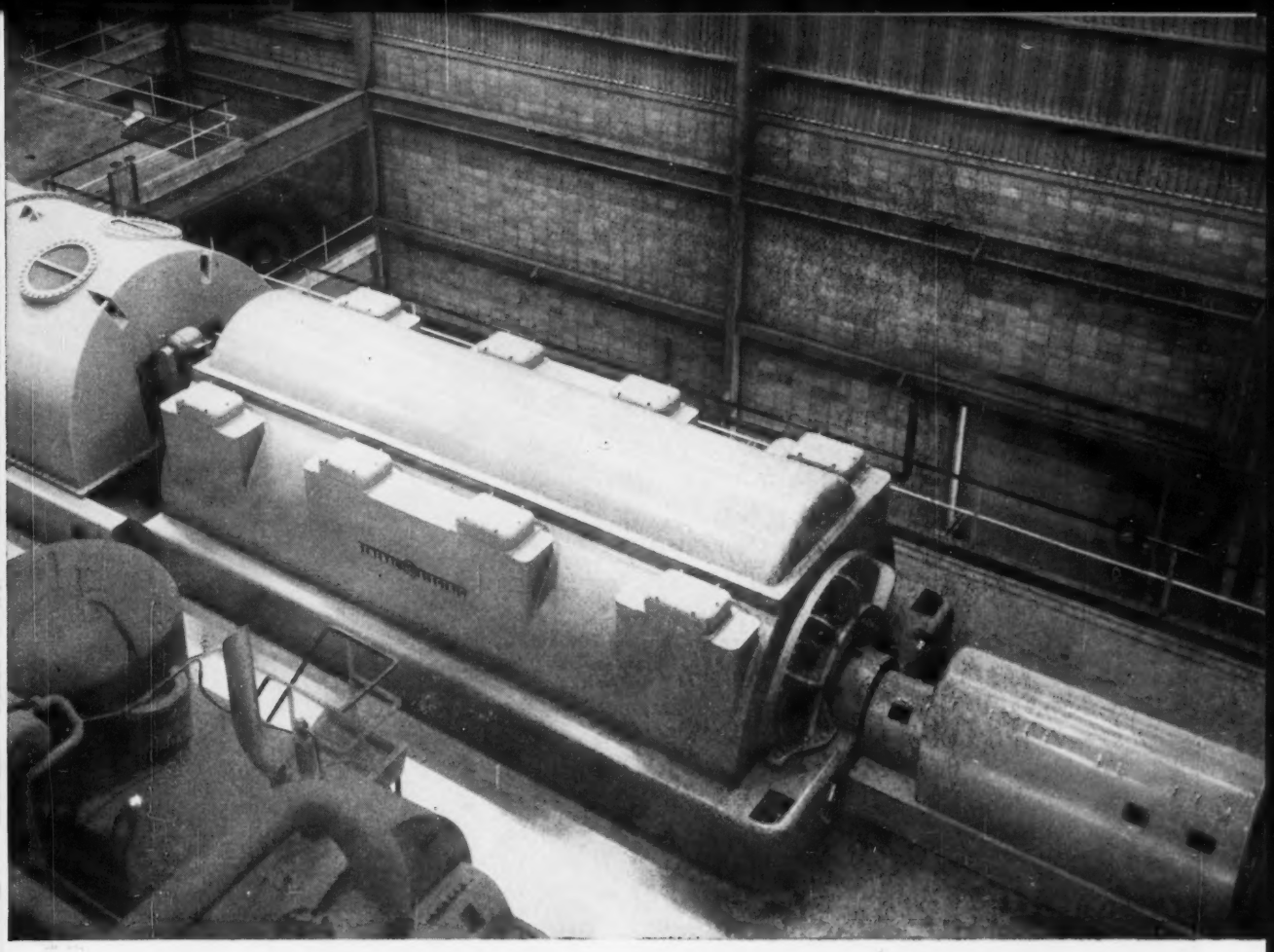


MICAPAL INSULATION better withstands high voltages and variable stresses caused by differential thermal expansion and contraction in large generator stator windings. Micapal is used on this 183,824-kva generator installed at Pacific Gas and Electric's Morro Bay Station.

How General Electric Micapal



INSULATION TESTS such as pictured here are used to compare the dielectric breakdown of different insulations. Forced to carry voltages far above their rating, test bars of various types of insulation first develop corona streamers, then finally fail, enabling engineers to measure the insulation's actual voltage endurance.



insulation extends generator life

IMPROVED INSULATION BETTER WITHSTANDS HIGH VOLTAGES, VARIABLE STRESSES

Now, after extensive research and four years of operating experience, General Electric announces the extended application of Micapal insulation for high-voltage stator windings. A major advance in providing still longer, more reliable operation, this mica-based insulation offers these distinct advantages:

Greater Tensile Strength. Micapal incorporates mica mat and some mica flake bonded with a duplex thermosetting resin. Mica mat is finely divided, reconstituted mica formed into sheets. The thermosetting binder, combined with uniform mica structure, makes Micapal much tougher at operating temperatures than earlier insulations.

Greater Dimensional Stability. Micapal is molded to the precise shape of generator armature bars. Because of thermosetting qualities, the insulation won't flow or lose shape. It possesses great mechanical strength over the full range of operating temperatures.

Improved Thermal Conductivity. Micapal removes heat from electrical conductors more easily. The result is that for a given current and same insulation thickness, the armature bar runs cooler.

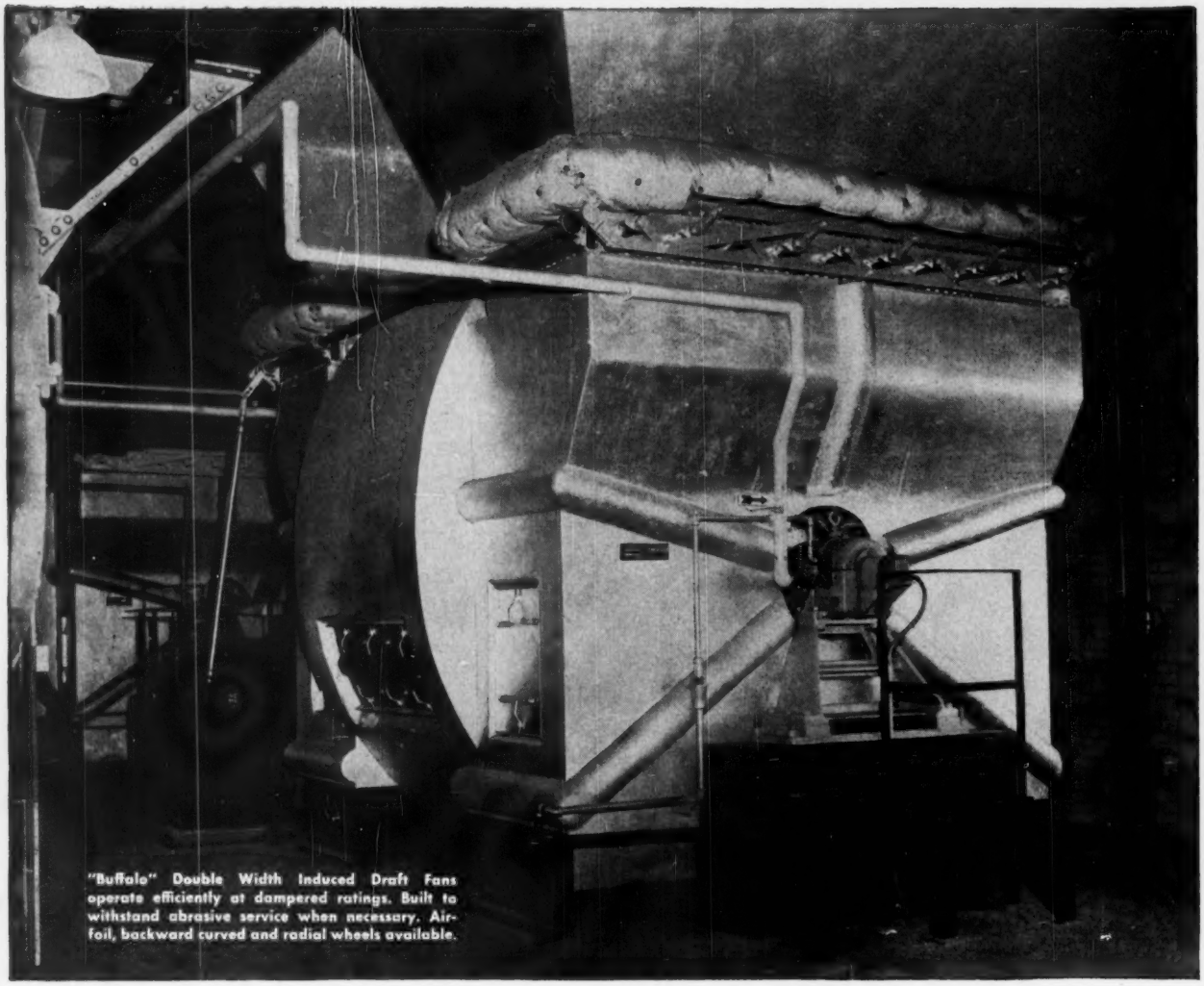
Improved Dielectric Breakdown Strength. The voltage endurance characteristics shown on the chart, above, illustrate how Micapal insulation withstands a much higher voltage than other mica insulation for any given period of time. The impulse puncture structure of Micapal has been shown by laboratory tests to be higher by an even greater factor.

Improved Micapal insulation is just another example of General Electric steam turbine-generator progress in meeting tomorrow's power demands. For more information on new generator developments, write Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, New York.

254-41

Progress Is Our Most Important Product

GENERAL ELECTRIC



"Buffalo" Double Width Induced Draft Fans operate efficiently at dampered ratings. Built to withstand abrasive service when necessary. Airfoil, backward curved and radial wheels available.

"Buffalo" AIRFOIL FANS MEET EXACTING

Pacing the airfoil's rise to popularity for mechanical draft service, the "Buffalo" Airfoil offers many unique design and construction

- A completely streamlined inlet and matching wheel flange for completely smooth half-circle entry — no flat spots.
- Extra-wide airfoil blades with tips to full channel width — for extra-deep "bite".

TYPE "BA", the basic wheel design for mechanical draft applications.

TYPE "CA", for conditions of higher pressure and lower capacity.

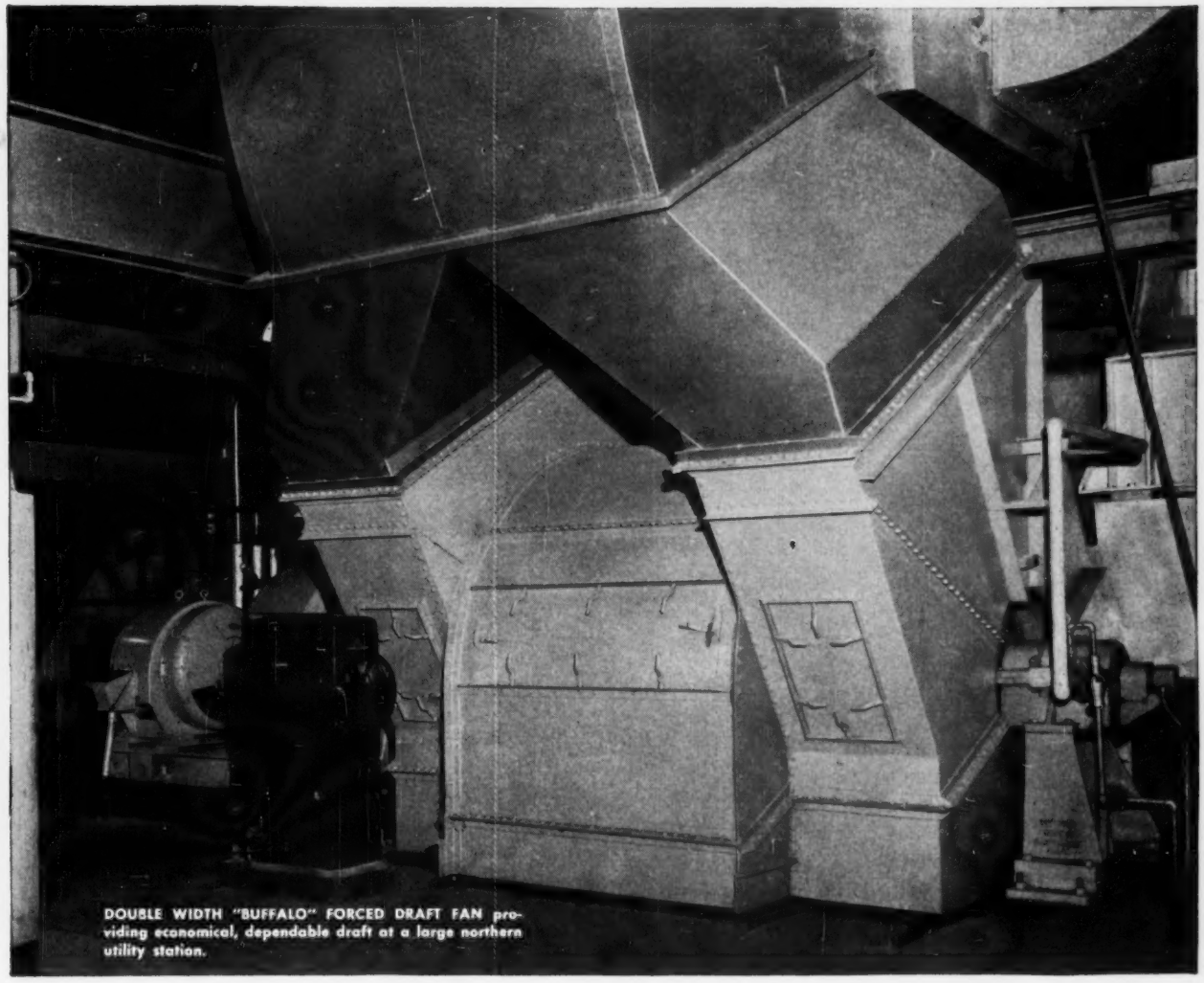
TYPE "AA", for lower pressures and higher capacities.

TYPE "CLM", one of 3 semi-airfoil wheels approaching performance of full airfoil wheels.

THE COMPLETE "BUFFALO" AIRFOIL SERIES TO MATCH ALL SPECIFIC OPERATING CONDITIONS

All wheels variable as to width for exact match of pressure-volume requirements with no sacrifice in efficiency. If you are interested in the finest draft service, write today for Bulletin FD106.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT



DOUBLE WIDTH "BUFFALO" FORCED DRAFT FAN providing economical, dependable draft at a large northern utility station.

MECHANICAL DRAFT REQUIREMENTS

features found in no other fan. By combining modern fan engineering with traditional "Q" Factor* construction, "Buffalo" has given the industry an airfoil fan offering these important features:

- Strength and rigidity in the wheel — massive smoothly curved hub — heavy plate formed flanges welded to blades.
- "Buffalo" divergent outlet reduces outlet turbulence common to fans without such an outlet — provides smooth conversion from velocity to static pressure.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

BUFFALO FORGE COMPANY

BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Enlarged drawing of Thermalastic insulation tape. High coil voltage can't get through the fish scale barrier of large mica splittings. The patented *elastic* impregnant expands and contracts with the coil to prevent tape separation; that's the *big difference* between Thermalastic insulation and other types.

Here's why Thermalastic insulation ends major cause of generator and motor failure

LARGE mica splittings have long been recognized as the most reliable coil insulation material, but for years it seemed impossible to find the RIGHT impregnant for the insulation tape.

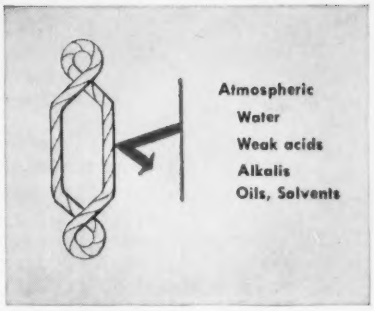
Some were too brittle and others too plastic at high coil temperatures; none could withstand repeated expansion and contraction of the coil . . . and sooner or later, tape separation caused failures.

Then the great discovery — In 1949, Westinghouse research scientists made *Thermalastic*® insulation a reality by discovering the "miracle resins" which cure to a *tough* resilient solid. Large mica splittings, overlapped like fish scales, are locked in this elastic bond which "breathes" . . . expands and contracts with the coil. It doesn't harden or soften with repeated heating by the coil. It doesn't deteriorate with age.

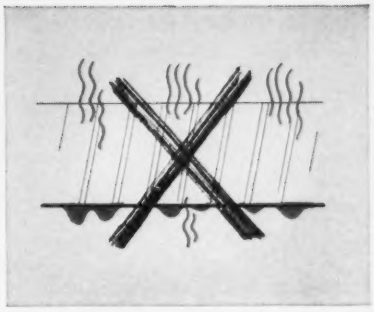
New color movie and bulletin show how and why Thermalastic insulation has extended the life of more than 40 million kva of generators and large motors. Contact your Westinghouse representative or write to Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-15004

YOU CAN BE SURE... IF IT'S

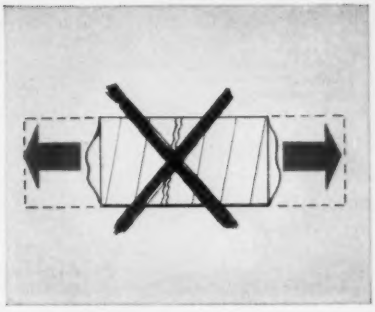
Westinghouse



Withstands attacks
which weaken and finally destroy other insulations. The Thermalastic insulation bond is void-free, has great density, and it's chemically inert. The physical strength of the resilient insulation wall is far greater than that of ordinary insulations.



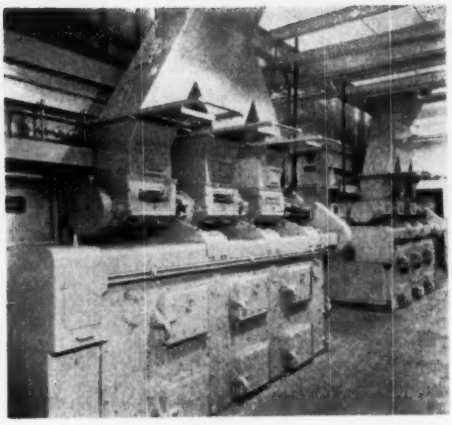
Doesn't soften or embrittle
The patented resins in Thermalastic insulation are thermosetting . . . heat changes them from a liquid to a permanently elastic solid which doesn't soften or embrittle after repeated heating. And it doesn't deteriorate while in storage or in use.



Not stressed
The insulated coil is heated to operating temperature, and *while it's expanded,* the resins cure to an ELASTIC solid. That's why Thermalastic insulation is relaxed when the coil expands, compressed when it contracts. It flexes when the coil is overloaded.

They wouldn't have believed it

Recent Steps in Stoker Development Would Astonish Pioneers of 60 Years Ago.



Typical Detroit Stoker installation. RotoStoker-CC

► Before the turn of the century when Detroit Stoker Company was founded, few power plant engineers would have believed possible the progress which 60 years has brought in coal burning equipment.

Ability of Detroit Stoker Company Engineers to foresee and to meet the ever changing needs in mechanized combustion over the years, has resulted in a series of new types of stokers that have kept this company in the forefront of the industry.

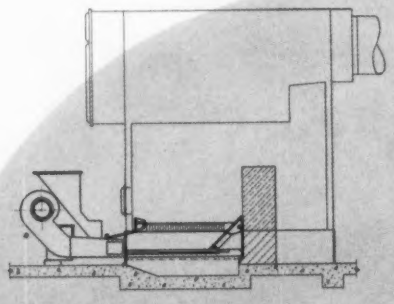
Pioneers in many developments. We were among the pioneers of the stoker industry in 1898 . . . among the first to use the underfeed principle and later the spreader principle. The spreader stoker, due to its great flexibility and ability to burn all grades of fuels has become the most widely accepted type of stoker today. Detroit Stoker engineers developed the Overthrow Rotor with curved blades, which insures uniform distribution of fuel over the entire grate.

We were the first to apply to spreader stokers the principle of divided grates, longitudinally sectionalized with a steam or air powered dumping section for each feeder to simplify ash cleaning.

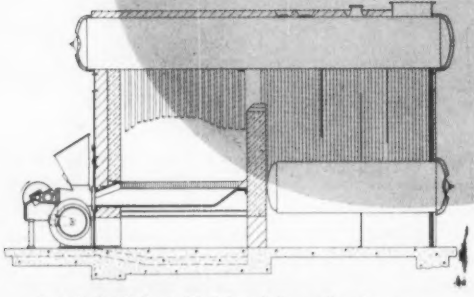
Also we were first to apply the continuous ash discharge principle to spreader stokers with the Detroit RotoGrate, which has a forward moving grate.

Addition to line. The RotoStoker, Type C-C (Continuous Cleaning) is our latest proven stoker type. Of the overthrow spreader type, it employs a unique design of horizontal reciprocating grates, which continuously move the ash forward, discharging it at the front.

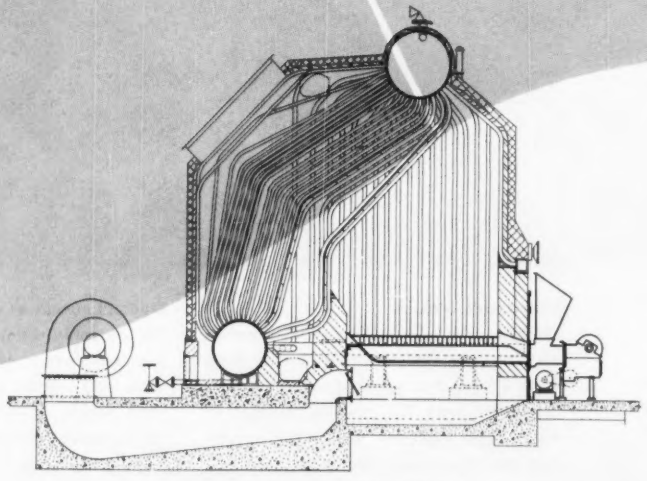
Lower excess air — higher heat release. Recent design improvement in RotoGrate air seals has resulted in reduction of excess air in the furnace to an extremely low point, consistent with higher furnace temperatures permissible with more furnace wall black surface in modern boilers.



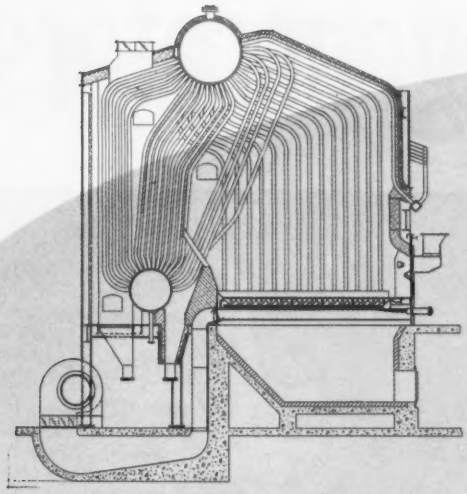
Detroit LoStoker. Single retort mechanically driven, plunger feed, side cleaning underfeed.



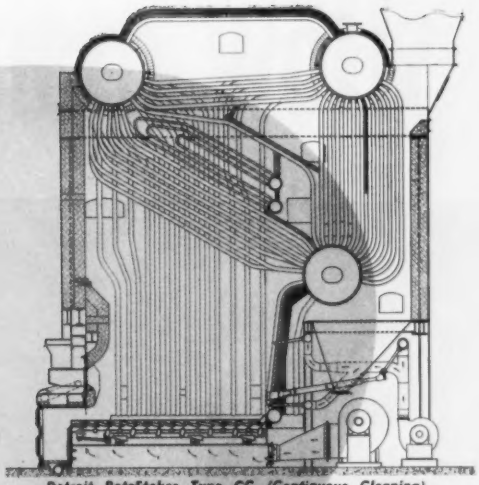
Detroit UniStoker with integral fan and motor . . . Detroit Single Retort Stoker with separately mounted fan and motor.



Detroit Double Retort Stoker. Plunger feed, side cleaning underfeed.



Detroit RotoStoker. Spreader type. Has high burning rates and handles a wide variety of fuels.



Detroit RotoStoker Type CC (Continuous Cleaning). Spreader Stoker with unique design of horizontal reciprocating grates which discharge ash at front.

Pioneering in design for higher heat release per square foot of grate has kept pace with this same trend in boilers.

Handling wide load ranges. Development of RotoGrate Convertible Grate Area Dampers has made possible efficient handling of load ranges of more than ten to one without smoke, while maintaining uniform steam pressure.

Gravity cinder return. Methods of returning fly ash carryover to the furnace to consume combustible matter and the use of overfire air to promote furnace turbulence for suspension burning are constantly being improved and refined.

Latest of these refinements and first in the industry is the Gravity Flow System for cinder return with RotoGrate Stokers. Where boiler design permits, cinders from collection points are deposited by gravity on the rear end of the grate. Improved design of air seal permits a "quiet" or coking section here. Cinders agglomerate with the green fuel, fly carbon burns on the grate and does not recirculate.

Dust loading of gases is substantially reduced and even with very low excess air, no slagging tendency is observed on the furnace walls, fuel bed, or furnace exit.

Hydraulic drive. Hydraulic Grate Drives are standard on RotoStokers Type C-C and are now available on RotoGrate Stokers. Hydraulic Drive for the RotoGrate includes a fluid motor to drive the feeders.

New feeder. Where conditions warrant, a newly developed Chain Conveyor Type Rotor Feeder provides infinitely variable control of feed over a much wider capacity range. Moving parts are sealed against dust and dirt and run in an oil bath. Feed is positive and continuous with even the wettest and most sticky fuels.

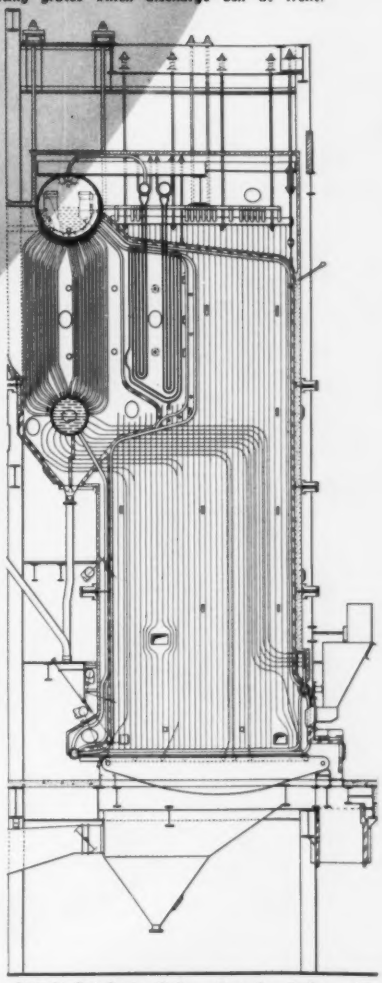
Burn waste fuels. Special Feeders are available for burning waste and refuse fuels such as bark, mill waste wood, bagasse, coffee grounds and many others either separately or in combination with coal.

Installation savings with stoker fired packaged boilers. Recent, also, is the adaptation of both underfeed and spreader type stokers to package boilers of several manufacturers. The stoker is assembled and shipped with the boiler. Available in sizes up to boiler shipping limits—approximately 35,000 pounds of steam per hour.

Wide range to meet your needs. A complete line — LoStoker, UniStoker, Double Retort Stoker, which are Underfeed Type — RotoStoker, RotoStoker C-C, RotoGrate, Overthrow Spreader Types . . . permits us to offer unbiased recommendations for all plant conditions and for boiler capacities from about 3,000 pounds to 400,000 pounds of steam per hour.

Our engineers will be happy to work with you in solving any of your combustion problems . . . to recommend stoker equipment to burn the type of fuel most economical and available to you. No obligation.

DETROIT SINCE 1898 STOKERS



Detroit RotoGrate Stoker. Spreader Stoker with forward moving grates which continuously discharge ash at front. Note gravity cinder return.

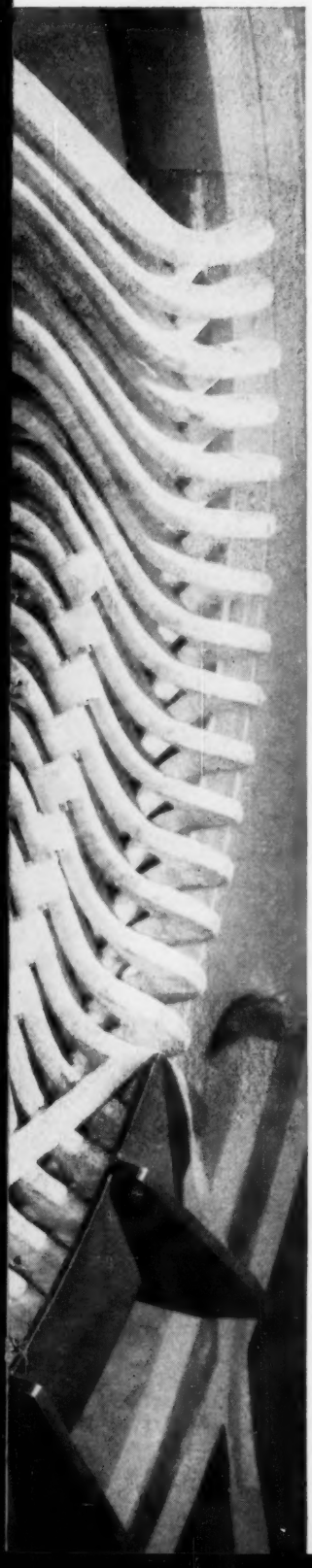
DETROIT STOKER COMPANY

Main Office and Works, Monroe, Michigan

District Offices and Representatives
In Principal Cities of U.S. and in Hawaii and The Philippines

How many generators to

produce 24,000,000 kw ?



About 22,000—so far. That is the number of generators Electro-Motive has built during the past twenty years, for a total generating capacity of more than 24,000,000 kw.

As a leading manufacturer of electrical equipment, Electro-Motive has not only produced thousands of generating units, but in the process, has also contributed materially to "improving the breed." Electrical engineers at Electro-Motive are continuously experimenting with new design improvements, new processes that result in more efficient, longer-lived units.

It is this background of experience in production, design and research that stands behind Electro-Motive power equipment. It is your assurance of dependability, economy and long life under the difficult applications of low load factor generation for which they were designed. Why not ask your Electro-Motive representative for additional information?

1000 kw units for use on sidings or placed on piers for semi-permanent use.

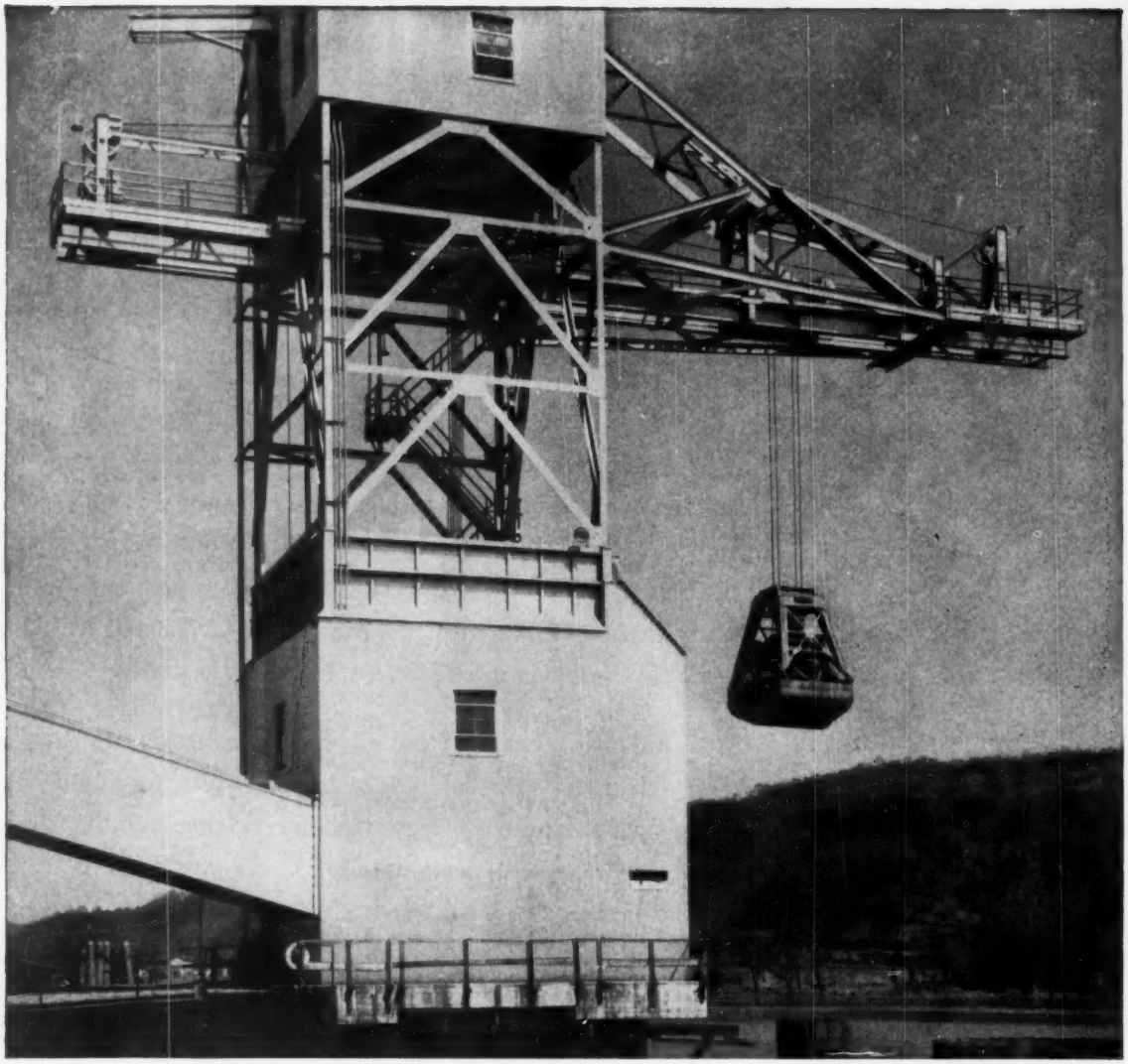
500 kw units offer excellent mobility for many temporary applications.

LIVE BETTER ELECTRICALLY

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS

LA GRANGE, ILLINOIS

Sales offices in Chicago, New York, St. Louis, San Francisco
In Canada: General Motors Diesel, Limited, London, Ontario



Rope-operated coal unloader designed, built and installed by Dravo for a large generating plant on the Monongahela River

Efficient tower keeps coal unloading costs down

This Dravo rope-operated unloading tower, installed on a Dravo dock is equipped with a 7½ ton bucket. With an operating cycle of 34 seconds from barge to hopper, the tower has a free digging capacity of 800 tons per hour.

Dravo towers feature all-welded construction, a reeving system that reduces hoisting horsepower, independent, positive bucket closing and many other design advantages that mean low cost operation.

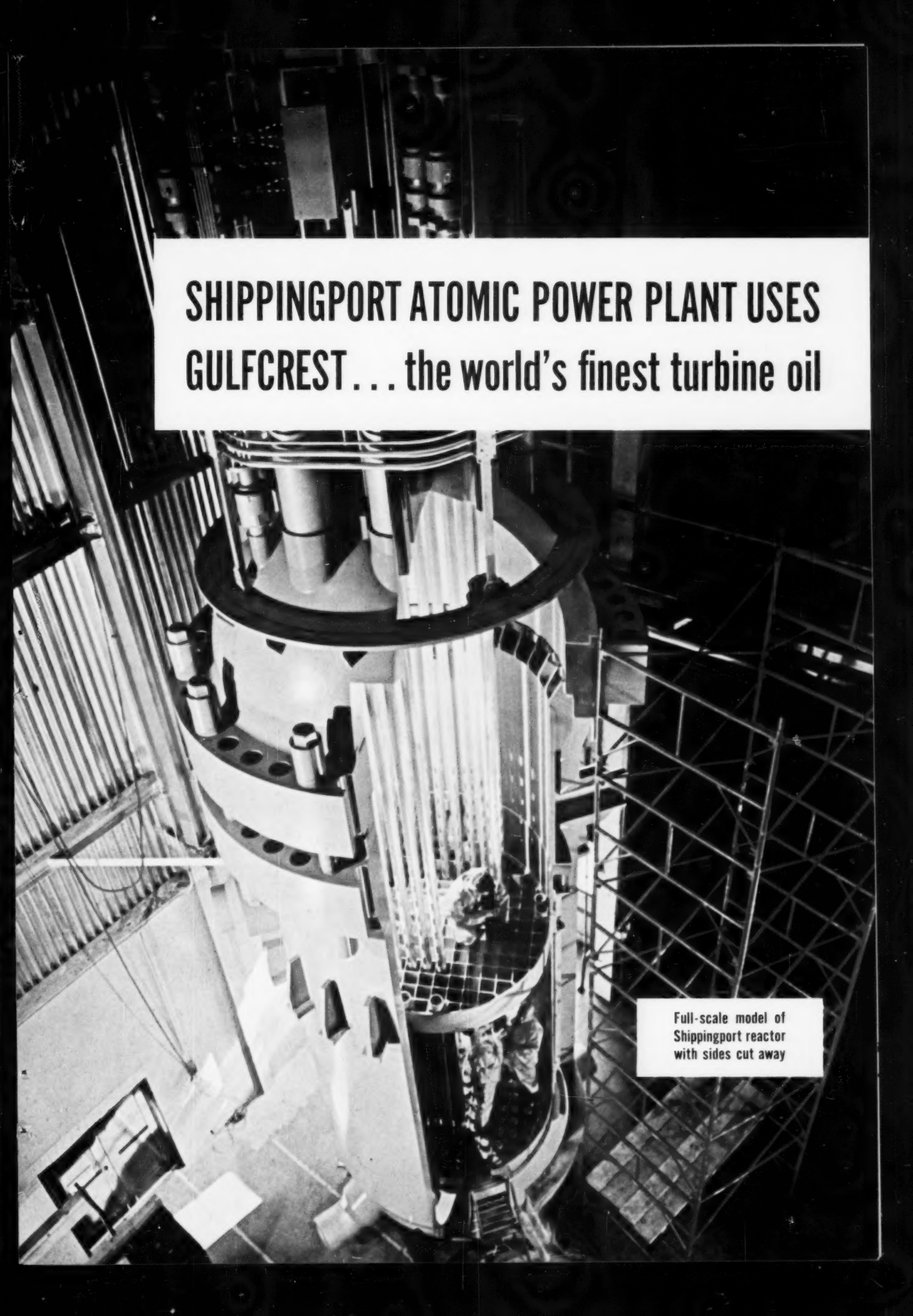
The Dravo cellular steel sheet pile dock requires no maintenance, and provides safe mooring for barges. It may support barge shifters and other auxiliary equipment as well as the unloading tower itself.

Both power companies and industrial plants have found that Dravo's more than 65 years of experience in the design, fabrication and erection of such complete facilities assures efficient and economical operation. Our engineers will be happy to discuss your particular problem, or to arrange for your visit to actual installations. Simply call us at Pittsburgh, SPalding 1-1200, or write DRAVO CORPORATION, PITTSBURGH 25, PA.

DRAVO

CORPORATION

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation



SHIPPINGPORT ATOMIC POWER PLANT USES GULFCREST . . . the world's finest turbine oil

Full-scale model of Shippingport reactor with sides cut away

Giant step toward abundant atomic power for all America!

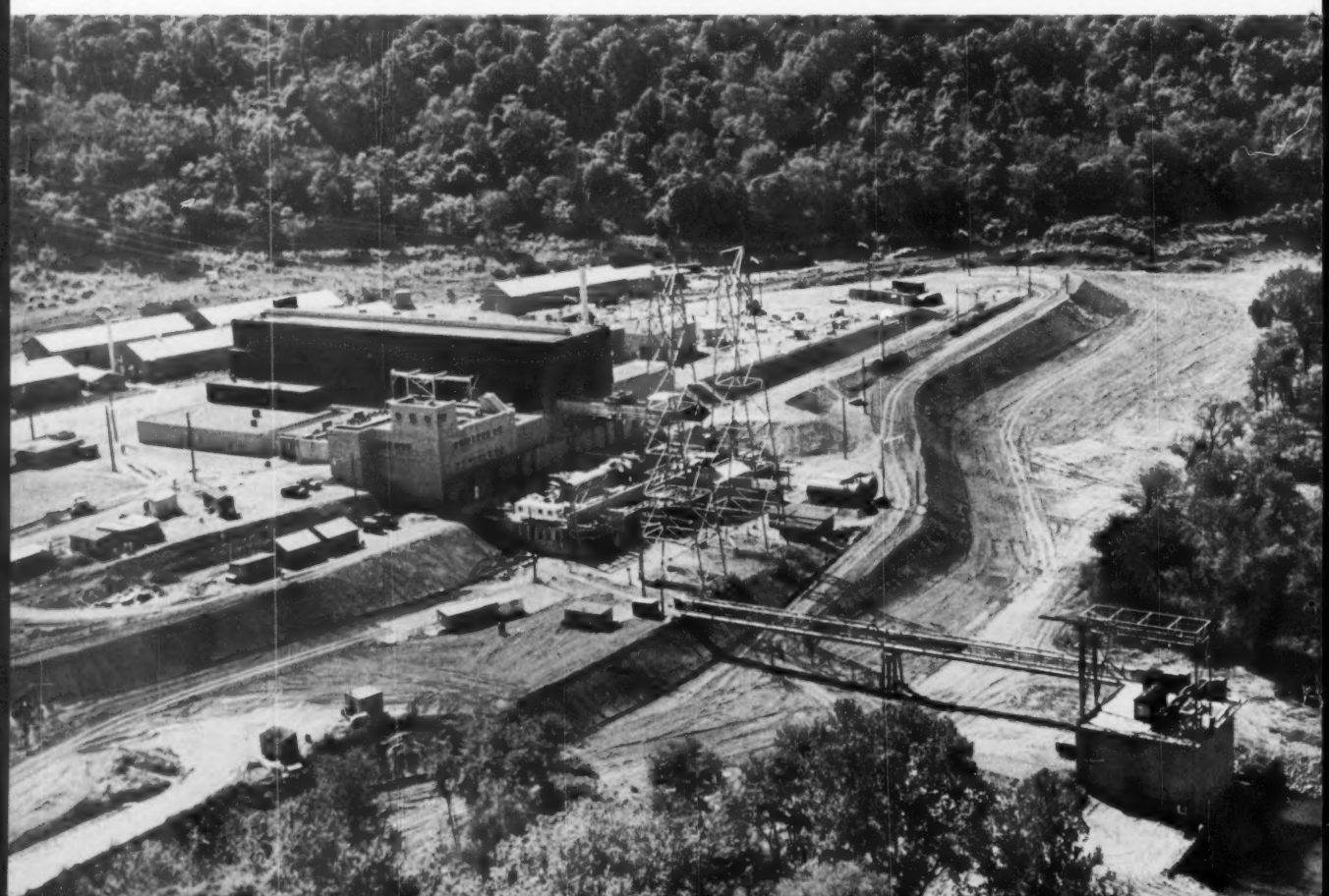
They're splitting atoms down on the Ohio, at Shippingport, Pennsylvania—and any day now electric power from nuclear fission will provide additional power and light for the Pittsburgh area.

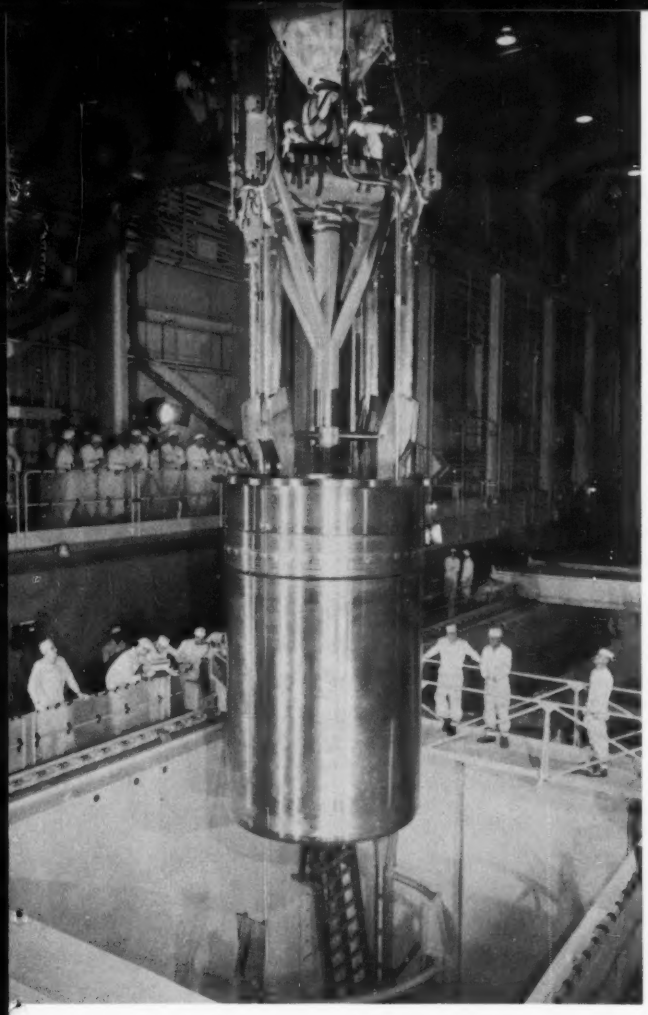
Shippingport is America's first full-scale atomic power plant for generating peacetime power—a joint venture of the U. S. Atomic Energy Commission and Duquesne Light Company. Westinghouse Electric Corporation designed and developed the nuclear components under contract with the Atomic Energy Commission.

The plant is powered by a pressurized water reactor. Fuel elements—a combination of 14 tons of natural uranium and 165 pounds of highly enriched uranium—form the "heart" of the reactor. Sheathed inside a steel pressure vessel, the reactor acts as a furnace, in which uranium atoms are split to produce heat. Water heated by this nuclear fission is pumped to heat exchangers, to make steam to spin the turbine. And the turbine-generator is lubricated by GULFCREST . . . the world's finest turbine oil.

A new source of energy is being harnessed at Shippingport!

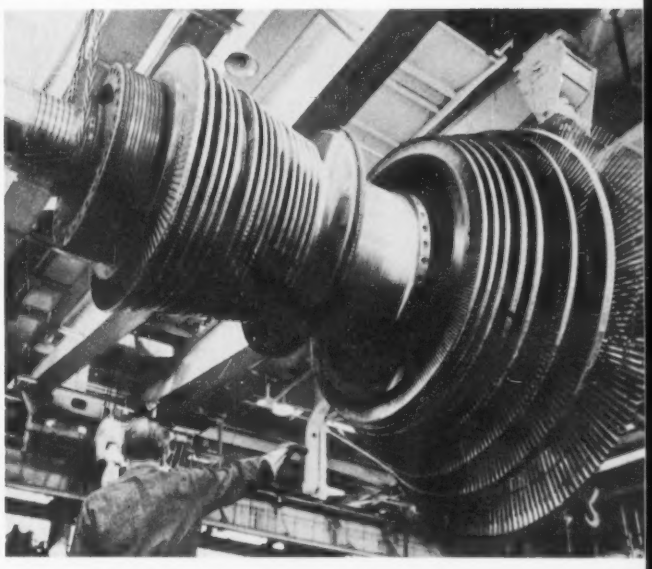
Experience gained here in nuclear power plant construction and operation will provide a firm basis for projecting the future of nuclear power generation. Gulf is proud that Gulfcrest turbine oil and Gulf service are playing a vital role at Shippingport—America's first full-scale atomic power plant.





Reactor core being lowered into place on October 6, 1957

Rotor for 100,000 kw Shippingport turbine



Reactor and heat exchangers go underground... the turbine-generator operates outside

A self-sustaining chain reaction of nuclear fission takes place when control rods are withdrawn from the "heart." Rods are made of hafnium metal, which can absorb neutrons and retard the heat-producing process. Inserting the rods reduces the number of atoms being split—withdrawing them increases the number.

Walls of the pressure vessel holding the nuclear reactor are 8" thick—of carbon steel, with ¼" stainless steel cladding. The reactor is inherently stable, with a built-in safety factor: "negative temperature coefficient." As reactor temperature increases, fissioning decreases.

Circulating water is heated by fission, under pressure to prevent boiling . . . goes to underground heat exchangers, makes the steam which drives the giant turbine-generator unit.

Built by Westinghouse for Duquesne Light Company, the unit will operate in the open, without walls or roof—the first such installation in this part of the country.

The complete turbine unit weighs 1,300,000 pounds, is 81 feet long, can handle over 1,400,000 pounds of steam per hour. It is designed to deliver 100,000 kw.

Gulfcrest was chosen as the ideal turbine oil for this power plant because of its past performance record in the electric utility field.

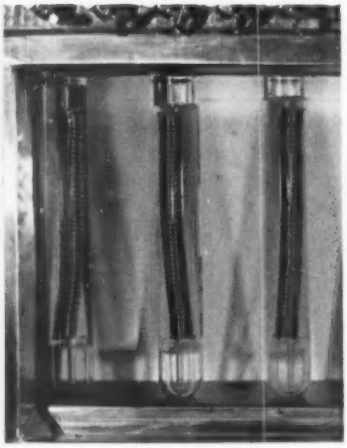
GULF

WHY GULFCREST GIVES UNMATCHED PERFORMANCE AND TURBINE PROTECTION . . .

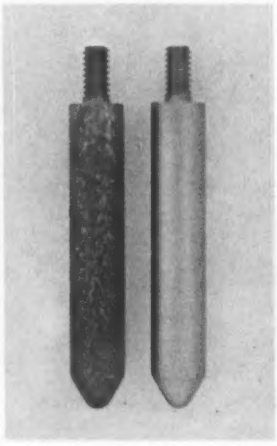
In Gulf's marketing area, more power is generated by central station steam turbines lubricated with Gulfcrest than with any other turbine oil . . . Here's why:

No other turbine lubricant offers the same oxidation resistance, corrosion protection, or anti-foam and anti-wear properties. Gulfcrest is ALCHOR-PROCESSED . . . an *extra* step in refining which eliminates more unstable hydrocarbons remaining after normal refining. Super-refined Gulfcrest performs every vital function of a turbine oil *better*—reducing friction, dissipating heat, minimizing the effects of air entrainment. Gulfcrest keeps turbine systems clean longer . . . has performed for as long as 20 years in some large turbines* without any significant rise in neutralization numbers . . . has provided safe, sure turbine protection for leading utilities for many years.

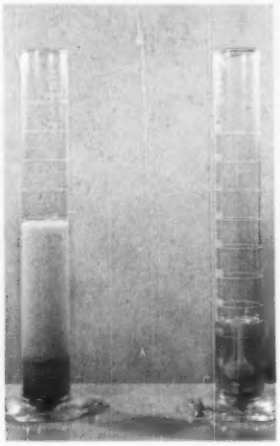
*Names on request



Here, iron and copper coils are immersed in oil heated to 203°F . . . oxygen is bubbled through in the presence of water.



Oil, water heated to 140°F. Polished carbon steel rod is immersed, rotated for 24 hours. Rod protected by Gulfcrest stays bright.



Air is blown into both oil samples. Gulfcrest stays free of foam!

Lab tests prove that Gulfcrest gives extra protection under boundary lubrication conditions.

GULFCREST has superior stability

Gulfcrest retains its golden color, even after many hours under this ASTM Test D-943-54! (Change of color would indicate hydrocarbon or additive deterioration.)

GULFCREST prevents corrosion

Gulfcrest contains "quick platers" for immediate protection, "slow platers" for reserve protection. Note how ASTM Test D-665-54 proves Gulfcrest's extra corrosion resistance!

GULFCREST prevents foaming

Gulfcrest is inhibited by a most effective silicone additive. There will be no foaming in the Shippingport turbine lubricating system.

GULFCREST, ideal for emergency conditions

Gulfcrest has superior anti-wear properties, as proved by this 4-ball wear tester. A special additive imparts these characteristics, which provide extra protection during critical operating periods.

GULF OIL CORPORATION
Department DM, Gulf Building, Pittsburgh 30, Pa.

Please send me the free booklet on Gulfcrest.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

Ask your Gulf man about Gulfcrest for your turbines . . . and mail this coupon for your free fact-filled booklet, in color, about Gulfcrest.

GULF

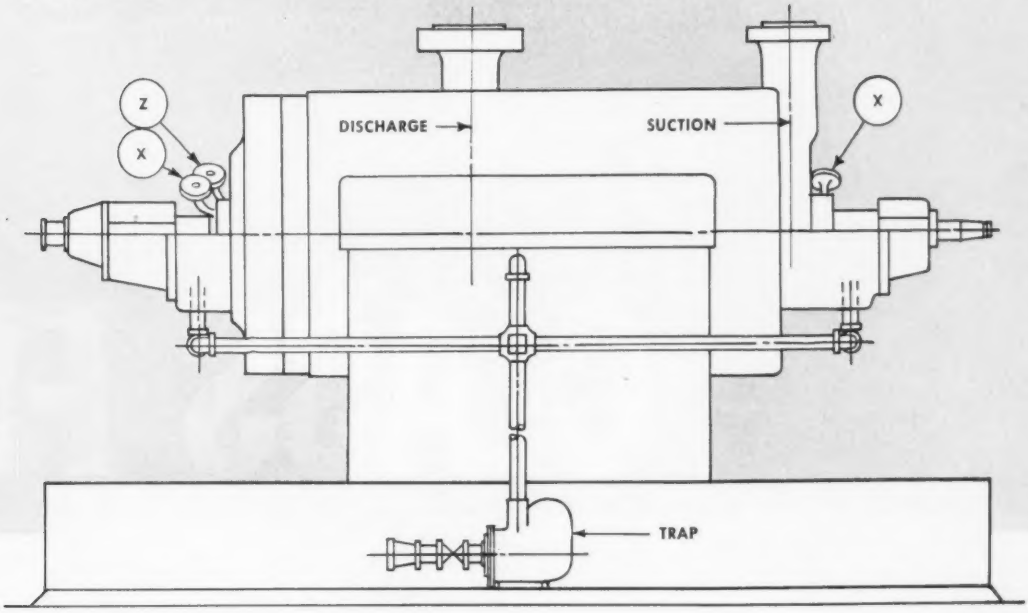
SP-9180

Arrangement of packingless sealing shows low-maintenance provisions. Condensate is piped to each stuffing box through line X. Condensate flows through an inner and then an outer serrated bushing. Drip catcher gathers condensate at each end — permits condensate to flow by gravity to a collecting trap. Condensate leakage is drawn back into the system by means of a condenser vacuum. Where no vacuum is present, an overflow pipe keeps leakage from entering the bearing bodies.

Line Z takes the high pressure bushing leakage back to the pump suction or to a heater. A needle valve following the trap will control flow back to the condenser.

Optional Sealing Arrangements

In addition to packingless seals, Allis-Chalmers offers standard packing, condensate bleed-in bleed-off arrangement, or mechanical seals — depending on your specific requirements.



PACKINGLESS SEALS

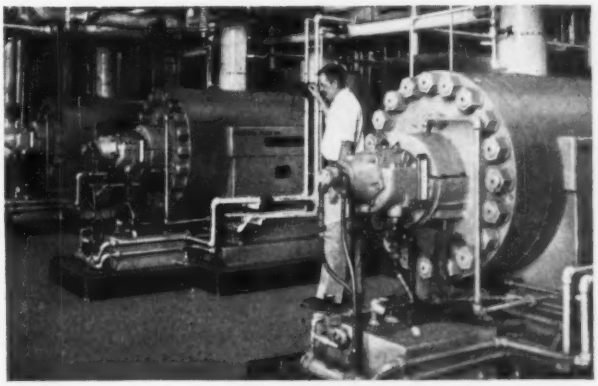
in ALLIS-CHALMERS barrel-type pumps

require no operator maintenance

Proven by performance in numerous power plants, the packingless seal arrangement available in Allis-Chalmers pumps means new station-operating economies. Here's why:

- Operator maintenance of stuffing box eliminated.
- No cooling water required for jacket and gland.
- Selection of smaller heater drain pumps often permitted.

Coupled with this low-maintenance design is the ultimate in efficiency that makes A-C barrel-type boiler feed pumps the most modern power plant pumps available. Contact your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



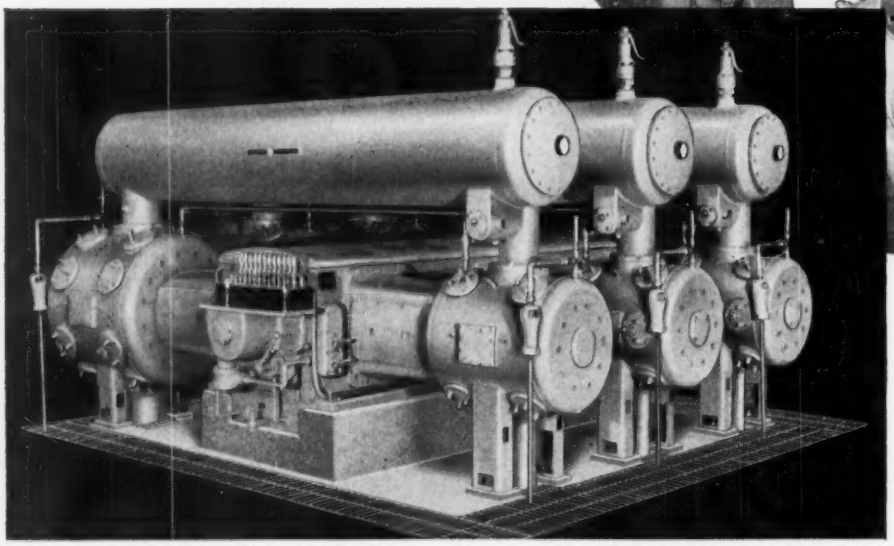
ALLIS-CHALMERS

A-5544

BUILT FOR

- *for vacuum service or pressures to 15,000 p.s.i.g.*
- *in sizes to 5,000 H.P.*
- *for direct motor mounting, flexible coupling or gear drive*

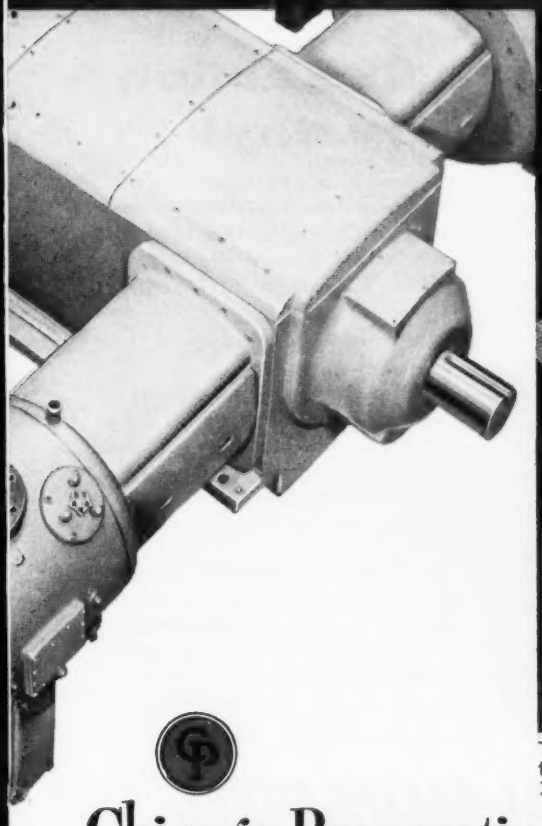
CLASS FE

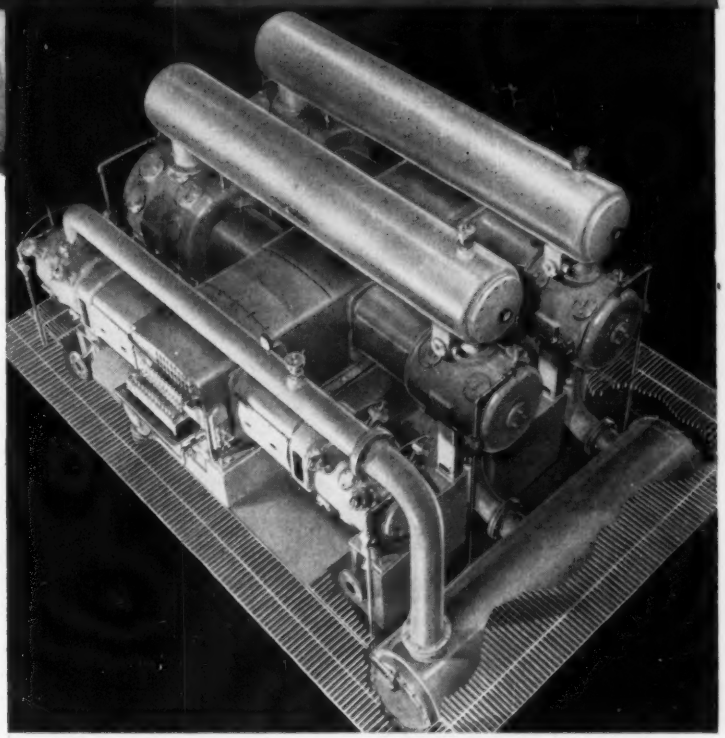


The six-cylinder compressor unit in the background photo above represents but one of numerous cylinder-crankthrow arrangements obtainable with the balanced-opposed Class FE. The unit shown directly above is a two-stage arrangement, 1000 H.P. size, one of two recently purchased by a large engine manufacturer.

HEAVY-DUTY

COMPRESSORS

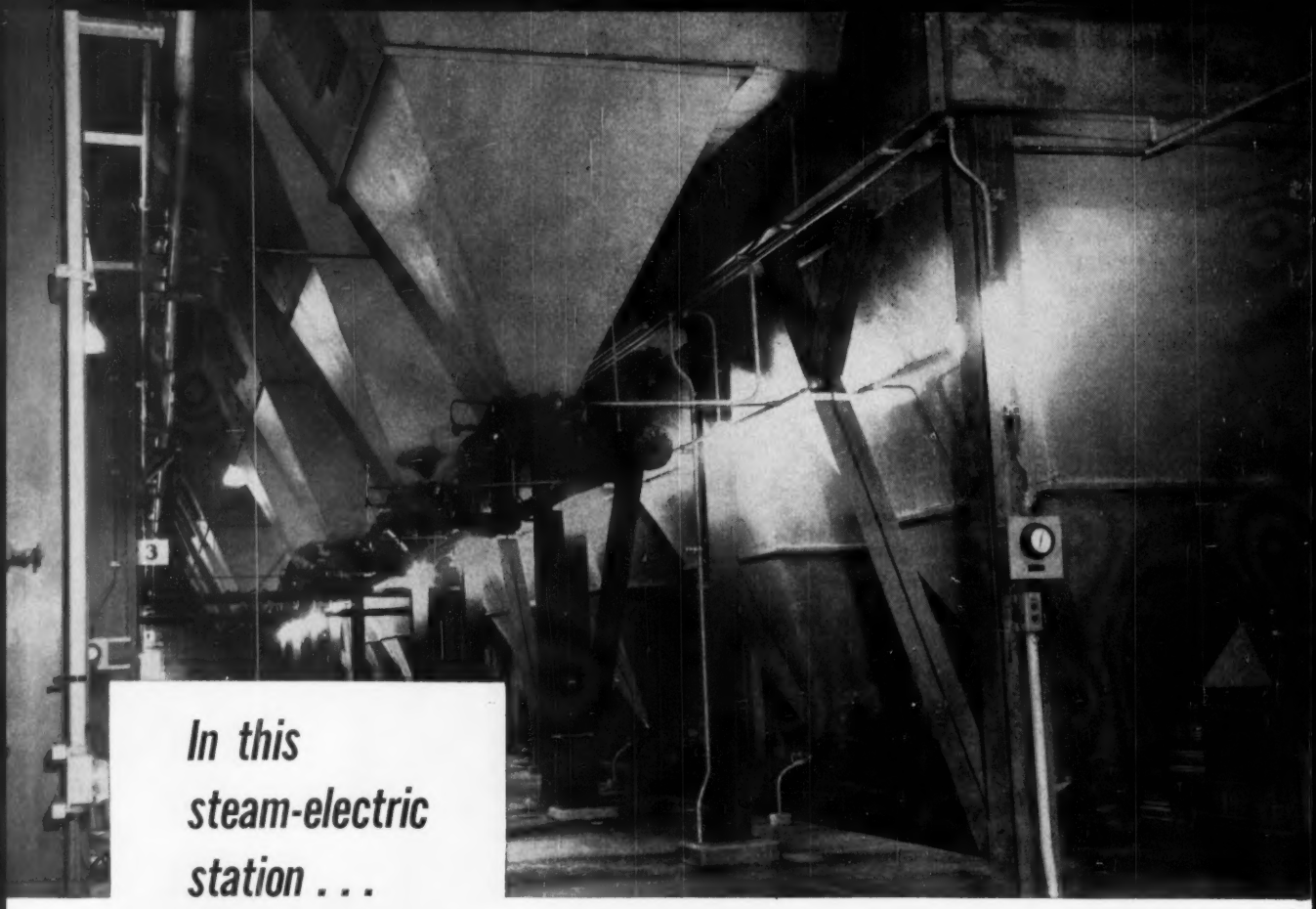




The high pressure compressor above is a further example of the flexibility of the balanced-opposed design. Here, the six-cylinder arrangement is used in a 1,250 H.P. three-stage compressor for wind tunnel service.

Chicago Pneumatic

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



In this steam-electric station . . .

USS "T-1" Steel resists abrasive action of 14,000 tons of coal every day!

28 million pounds of abrasive coal scour through this large power generation system every day! To insure good service and durability, USS "T-1" Steel is used at points of severe wear in coal chutes, hoppers, pulverizer feed pipes, exhaust pipes, and liners of ash collectors.

USS "T-1" Steel's exceptional *combination* of properties suits it ideally for equipment like this. Here's how "T-1" Steel cuts maintenance, repair and installation costs:

"T-1" Steel Lengthens Service Life. For maximum resistance to impact-abrasion, USS "T-1" is furnished quenched and tempered to 321 minimum Brinell. It is recommended wherever impact abuse is severe. Chutes, hoppers, ducts and similar equipment last longer when built with USS "T-1" Steel—especially when they must withstand abuse at sub-zero temperatures.

"T-1" Steel Reduces Weight. USS "T-1" Steel is also furnished quenched and tempered to 90,000 psi minimum yield strength, enabling designers to reduce the thickness of steel used in many supporting structures requiring both bars and fabricated plates. This reduces weight, reduces the amount of welding, cuts freight costs, and at times even lessens foundation requirements.

"T-1" Steel Is Weldable. Whether USS "T-1" Steel is furnished to 321 minimum Brinell or 90,000 psi minimum yield strength, it can be welded in the field *without pre- or post-heating*. This weldability—unique in a steel so strong and durable—permits on-the-spot fabrication at minimum cost.

Write for our new illustrated booklet "T-1" which contains design and application information, as well as helpful hints on fabrication of this versatile alloy steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS," "COR-TEN," "MAN-TEN," "TRI-TEN," and "T-1" are registered trademarks.

Other well-known USS steels used in coal handling systems are USS Stainless, USS Cor-Ten, USS Tri-Ten, USS Man-Ten and USS A-R steels.

UNITED STATES STEEL

ALLIS-CHALMERS

Water Conditioning

Announcing New Industrial Zeolite Water Softener

Basic standard water softener designs easily adapted to meet individual plant requirements.

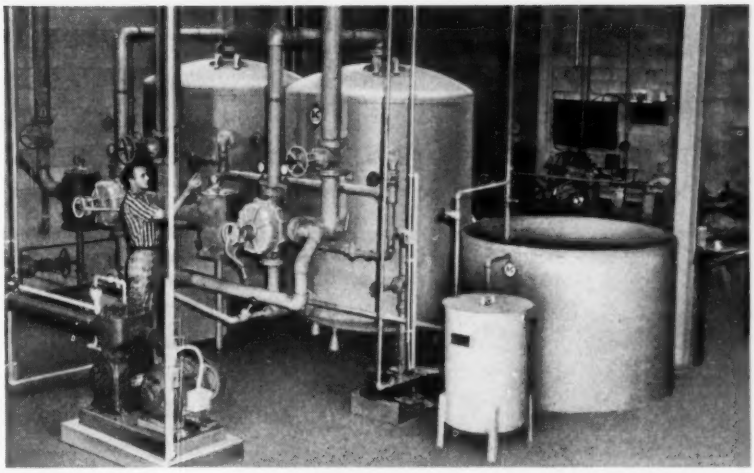
Here's a well-engineered, well-built answer to a wide range of water conditioning problems. It's designed to eliminate costly maintenance due to scaling of pipes and heat exchange tubes; to produce chemically suitable water for drying, paper making, textiles; and to provide water for food processing and many special industrial applications.

Easy Operation

The unit is basically simple. It is engineered to operate with little or no maintenance between regenerating cycles. Regeneration is an easy procedure. Automatic controls are also available to further simplify the operation if desired.

Standard Basic Design

Allis-Chalmers engineers started with a basic standard design developed from years of research and experience.



Allis-Chalmers sodium zeolite water softener installed in Ohio dye plant.

From this, a water softener is engineered to meet your individual plant requirements. Such factors as size of softener tank, size of salt and brine tank can be varied to meet your conditions.

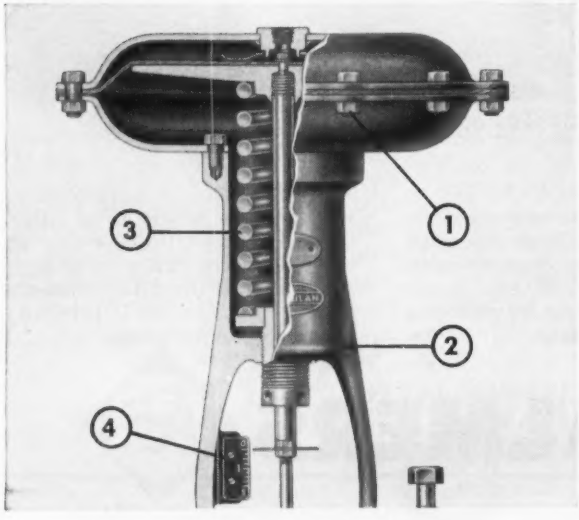
Get Details

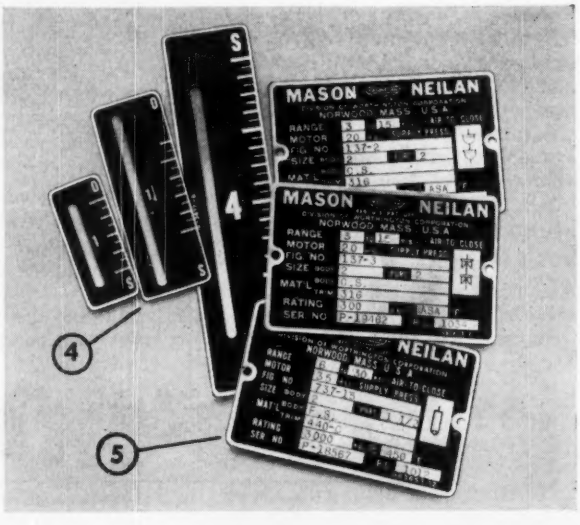
For complete details about Allis-Chalmers industrial type zeolite water softeners, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5552

(1) Bolted diaphragm case assures tightness, offers no pockets to accumulate moisture, permits use of flat stock diaphragms in emergency. (2) Cast iron yoke provides inherent rust resistance and rigidity — cannot get out of alignment. (3) Standard 6-30 psi range springs available (at no extra cost) for easy interchangeability with 3-15 psi range. (4) Stroke scale shows actual increments of plug travel. (5) Full specification data on serial plate gives complete information at a glance.





Masoneilan Control Valves Pioneer in

Design To Cut Downtime!

Practical Engineering Builds In Features to Speed Servicing, Reduce Time Losses

Practical engineering aims at reducing maintenance to a minimum and speeding unavoidable servicing. That's one reason Masoneilan Valves find such widespread acceptance — they combine the economies of long life, low service costs and minimum downtime.

Mason-Neilan pioneers many high C_q design features with the *maintenance man* in mind — making his job simpler and more speedily accomplished. Consider, for example, these ten ways in which proper design helps save important money. And for the full story on the complete line ask the office nearest you — or write

MASON-NEILAN

Division of Worthington Corporation

33 NAHATAN STREET, NORWOOD, MASSACHUSETTS

MASONEILAN

Sales Offices or Distributors in the Following Cities: New York • Syracuse
Chicago • St. Louis • Tulsa • Philadelphia • Houston • Pittsburgh
Atlanta • Cleveland • Cincinnati • Kansas City • Phoenix • Detroit
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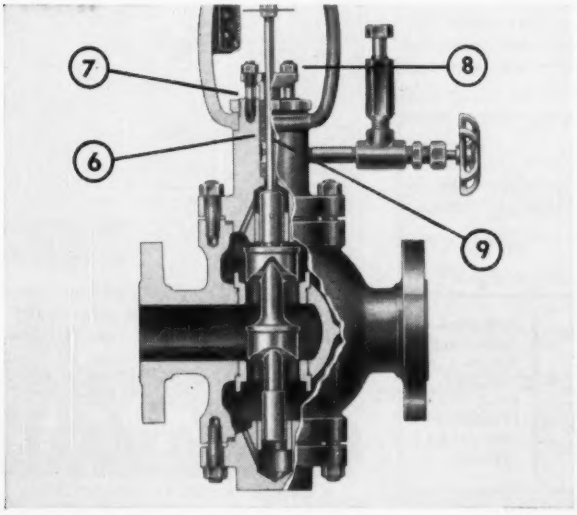
Charlotte • Los Angeles • Corpus Christi • Denver • Appleton
Birmingham • New Orleans • Seattle
Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

(6) Split-ring, preformed packing assures long service, ease of replacement. (7) Motor is easily removed from bonnet without disturbing packing box. (8) Bolted packing box assures maximum seal with minimum friction; provides visual check on packing life. (9) Superfinished stems move freely, reduce packing box friction, increase packing life. (10) Interchangeability of trim parts assures accurate fit of replacements, speeds conversion for change of process.



HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 5 OF A SERIES)

Ion Exchange Equipment

Ion exchangers are solids which can take a "charge" of cations or anions from one liquid and exchange them for different ions of the same polarity in another liquid. Example: "Permutit Q" Cation Exchanger, a sulfonated polystyrene resin. When operated on the "sodium cycle," this resin picks up calcium, magnesium, iron, manganese or aluminum cations from water containing these materials and gives off sodium cations in exchange. When exhausted, the resin is regenerated with a brine (sodium chloride) solution that supplies new sodium cations.

The Table below lists ions commonly found in water and the ion-exchange systems by which they can be removed.

Softening: Removing calcium and magnesium ions that cause boiler scale, soap curd, etc. Done with a cation exchanger, sodium cycle, which also removes iron, manganese and aluminum ions.

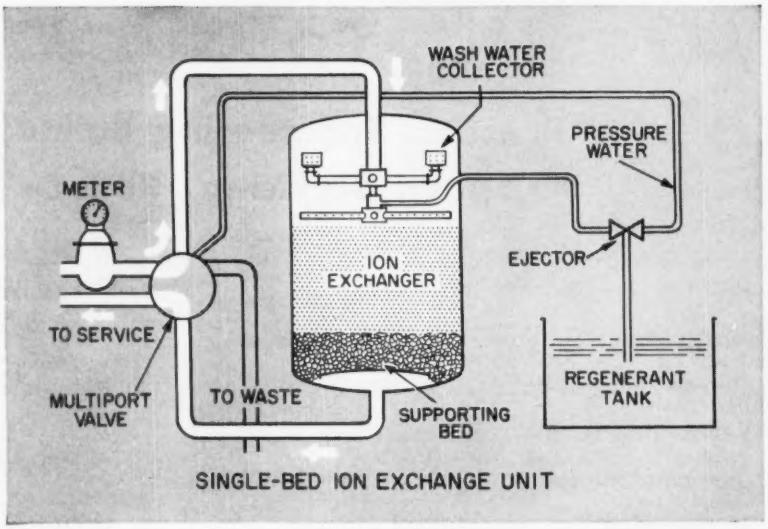
Dealkalizing: Removing bicarbonates and carbonates, generally from boiler feedwater, to reduce corrosion due to CO_2 in condensate returns. Done in 2 steps: cation exchanger, sodium cycle, then strongly basic anion exchanger, chloride cycle.

Demineralizing: Removing cations and anions. Up to nine or ten combinations of exchangers with one to four steps are used depending on the raw water and the degree of purity required for a specific use.

Functions of equipment

Ion exchange equipment is designed to accomplish these basic cycles: The *service run* during which the water flows through the bed of ion exchanger (usually downflow); *backwashing* (upflow) for removing suspended solids filtered out by the ion exchanger; *regenerant introduction* (either upflow or downflow) which restores the capacity of the ion exchanger and *rinsing* which removes the excess regenerant from the bed.

A manual or automatic motor-driven multiport valve replaces a number of individual valves and greatly simplifies regeneration. Rubber-lined multiport valves are used under corrosive conditions.



SINGLE-BED ION EXCHANGE UNIT

Length of service run is usually controlled by the volume of water through an electric-contact water meter or by automatic water-quality testing instruments such as a conductivity meter.

SINGLE-BED UNITS for softening, dealkalizing, demineralizing

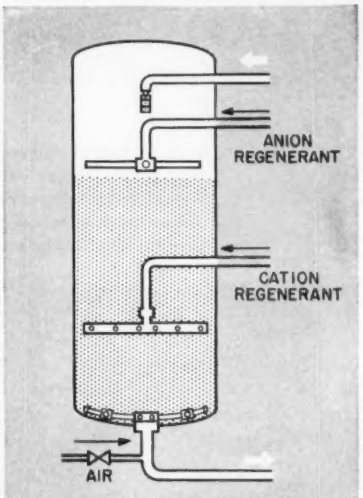
These units contain one type of ion exchanger (cation or weakly basic anion or strongly basic anion). They are similar to pressure filters with ion exchanger in place of the sand and a more efficient distribution and collection system for more uniform flow through the bed.

Two or more single-bed units are required for demineralizing . . . one or more for a cation exchanger and one or more for each type of anion exchanger used.

MIXED-BED UNITS for demineralizing

Mixed-bed units contain both cation and anion exchangers. These are thoroughly mixed prior to the run and provide a multiple-step demineralization.

Backwash rate is closely controlled so that it separates the ion exchanger resins by lifting the lighter anion resin beds over the heavier cation resin. The beds are then regenerated and rinsed while separated, then mixed by air jets from the bottom of the tank and given a final downward rinse before the service run.



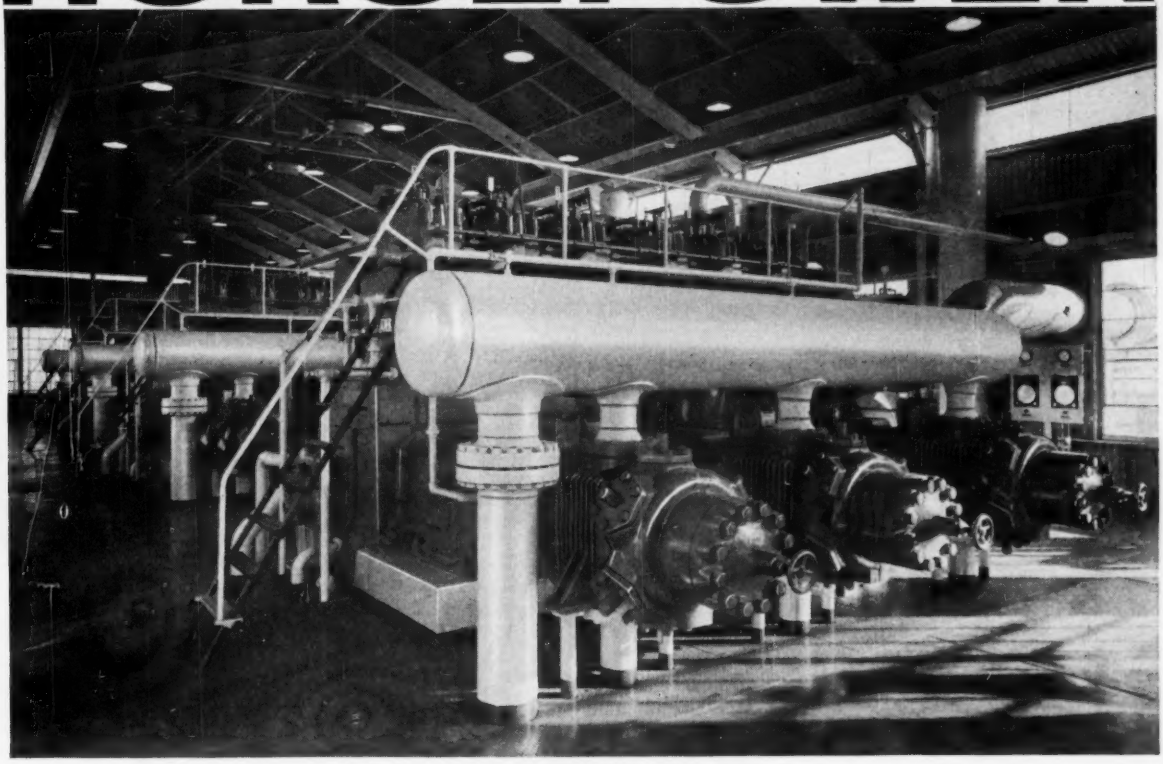
MIXED-BED ION EXCHANGE UNIT

CATIONS	Calcium Ca^{++} Magnesium Mg^{++}	Exchanged for sodium ions by CATION EXCHANGER regen. with sodium chloride.		Exchanged for hydrogen ions by CATION EXCHANGER regen. with acid.	
	Iron Fe^{++} Manganese Mn^{++} Aluminum Al^{+++}				
	Sodium Na^{+} Potassium K^{+}				
ANIONS	Chloride Cl^{-}	Taken up as complete acid molecule by WEAKLY BASIC ANION EXCHANGER regen. with soda ash or caustic.		Exchanged for chloride ions by STRONGLY BASIC ANION EXCHANGER regen. with sodium chloride.	Exchanged for hydroxyl ions by STRONGLY BASIC ANION EXCHANGER regen. with caustic.
	Sulfate $SO_4^{=}$ Nitrate NO_3^{-}				
	Bicarbonate HCO_3^{-} Carbonate $CO_3^{=}$				
	Silicate $HSiO_3^{-}$				

For information on ion exchange resins and equipment, as well as other water-conditioning equipment, write: The Permutit Company, Dept. P-12, 50 West 44th St., New York 36, N.Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

PERMUTIT®
rhymes with "compute it"
A DIVISION OF PFAUDLER PERMUTIT INC.

431,190 HORSEPOWER



of Clark Turbo-supercharged Compressors acquired by industry

Since Clark introduced the world's first 2-cycle turbo-supercharged gas-engine-driven compressor in 1953, over 431,000 bhp. of these modern ultra-efficient units have been ordered by industry. Furthermore, of the 28 major companies who have acquired TRA or TLA units, 14 have placed as many as five repeat orders for additional compressors.

Much of this acceptance stems from designing in the Clark tradition. The TRA and TLA possess the stamina to back you up under the most difficult load conditions. They have been performance-proved by over 1,000,000 compressor hours on stream.

The TRA and TLA are the *only* modern compressors available that have been specifically designed for turbo-supercharging. Seven models from 1100-3400 bhp.

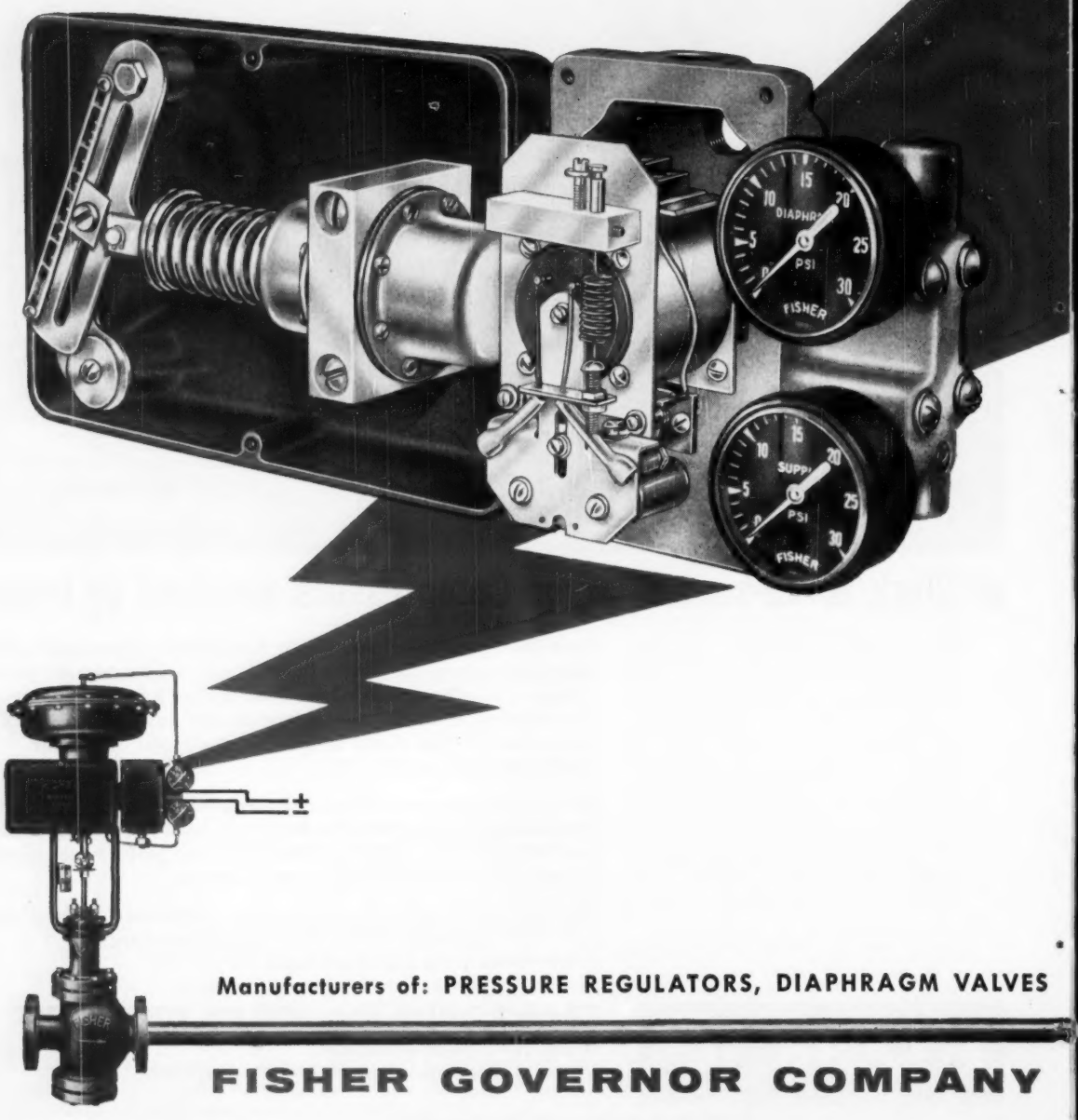
CLARK

CLARK BROS. CO., OLEAN, NEW YORK

One of the Dresser Industries
Offices in Principal Cities Throughout the World

Turbo-Supercharged Compressors

Announcing the.....



Manufacturers of: **PRESSURE REGULATORS, DIAPHRAGM VALVES**

FISHER GOVERNOR COMPANY

. . . a fast, sensitive electro-pneumatic valve positioner for dependable, accurate valve control

The FISHER E-POSITROL combines the advantages of fast transmissions from electronic controllers with the economy and dependability of pneumatically operated control valves.

The Type 3541 E-POSITROL consists of two units, First: The Type 541 Transducer, which produces a pneumatic out-put pressure that is proportional to a DC electrical in-put signal, Second: A pneumatic valve positioner (Type 3500) which accurately positions the valve stem as dictated by the pneumatic out-put pressure of the transducer.

A most important feature is that any FISHER Type 3500 Positrol valve positioner now in service can easily be converted to an electro pneumatic positioner by adding the transducer portion.

The transducer is attached to the side of a standard "Positrol" case and is available with different coils capable of utilizing a signal from any electronic instrument within the DC signal range of from .3 ma to 50 ma.

The transducer case is of explosion proof design. The FISHER E-POSITROL can be mounted on direct or reverse acting top works. Tests prove that stability, repeatability and frequency of response on this unit are excellent.

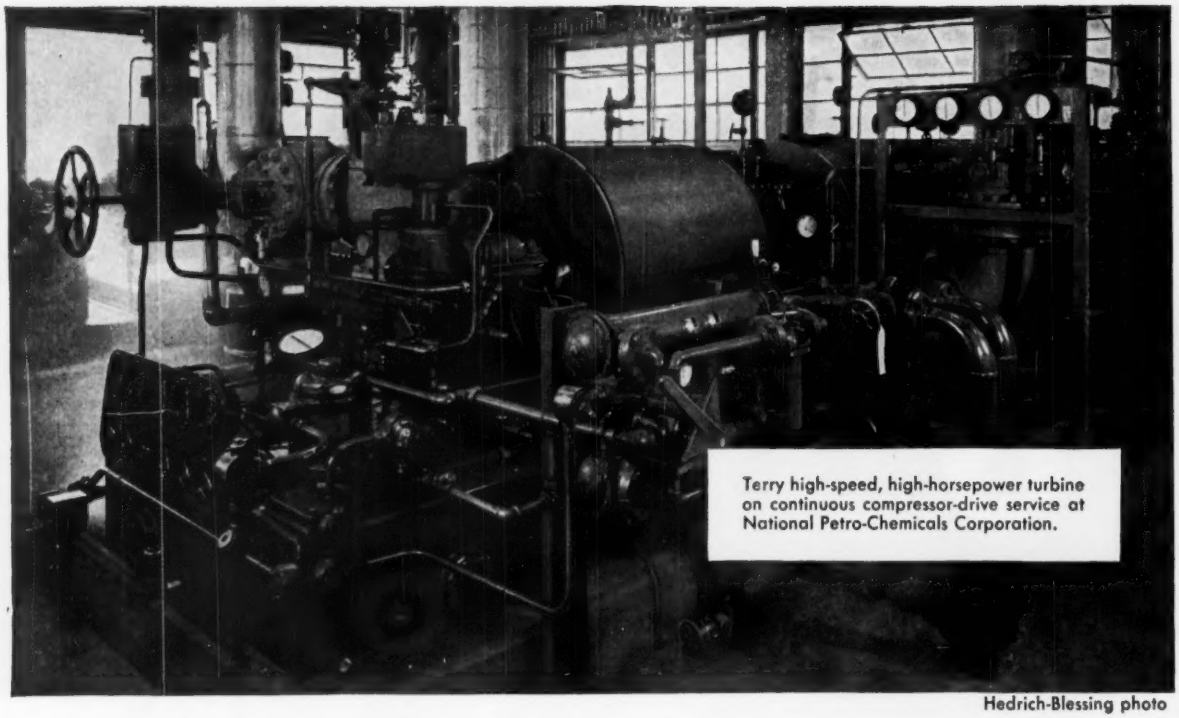
For full details write for Bulletin E-3541.

and LIQUID LEVEL CONTROLS

FISHER® Controls

Marshalltown, Iowa/Woodstock, Ontario

Since 1880

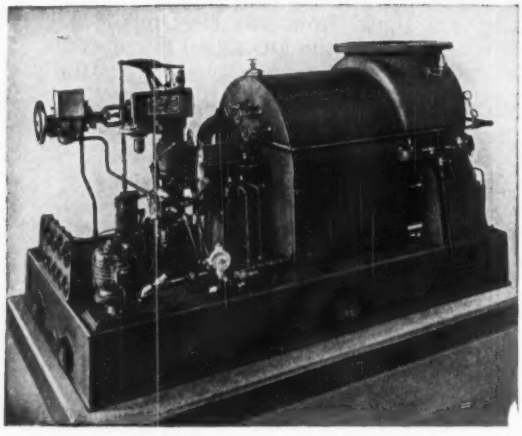


Terry high-speed, high-horsepower turbine on continuous compressor-drive service at National Petro-Chemicals Corporation.

Hedrich-Blessing photo

At National Petro-Chemicals Corporation . . .

Terry high-speed compressor-drive turbines provide continuous 'round-the-clock service



One of the two 5400 hp., 7486 rpm turbines built for the Tuscola plant of National Petro-Chemicals Corporation.

In the fall of 1953, five Terry multistage turbines were placed on day-and-night duty at the Tuscola, Illinois, Plant of National Petro-Chemicals Corporation. They drive high-speed compressors used to compress hydrocarbon gases in the production of ethylene.

The *excellent performance of these initial units later resulted in the installation of two more Terry machines.* These were placed in service some two years later.

In all, the seven turbines total more than 30,000 hp. They range in capacity from 3300 to 5400 hp., and in speed from 7500 to 9700 rpm.

The National Petro-Chemicals installation, and the thousands of other units serving in refineries and chemical plants throughout the world, are testimony to the low maintenance and consistent reliability of Terry turbines. Put Terry to work for you. Write for further information.

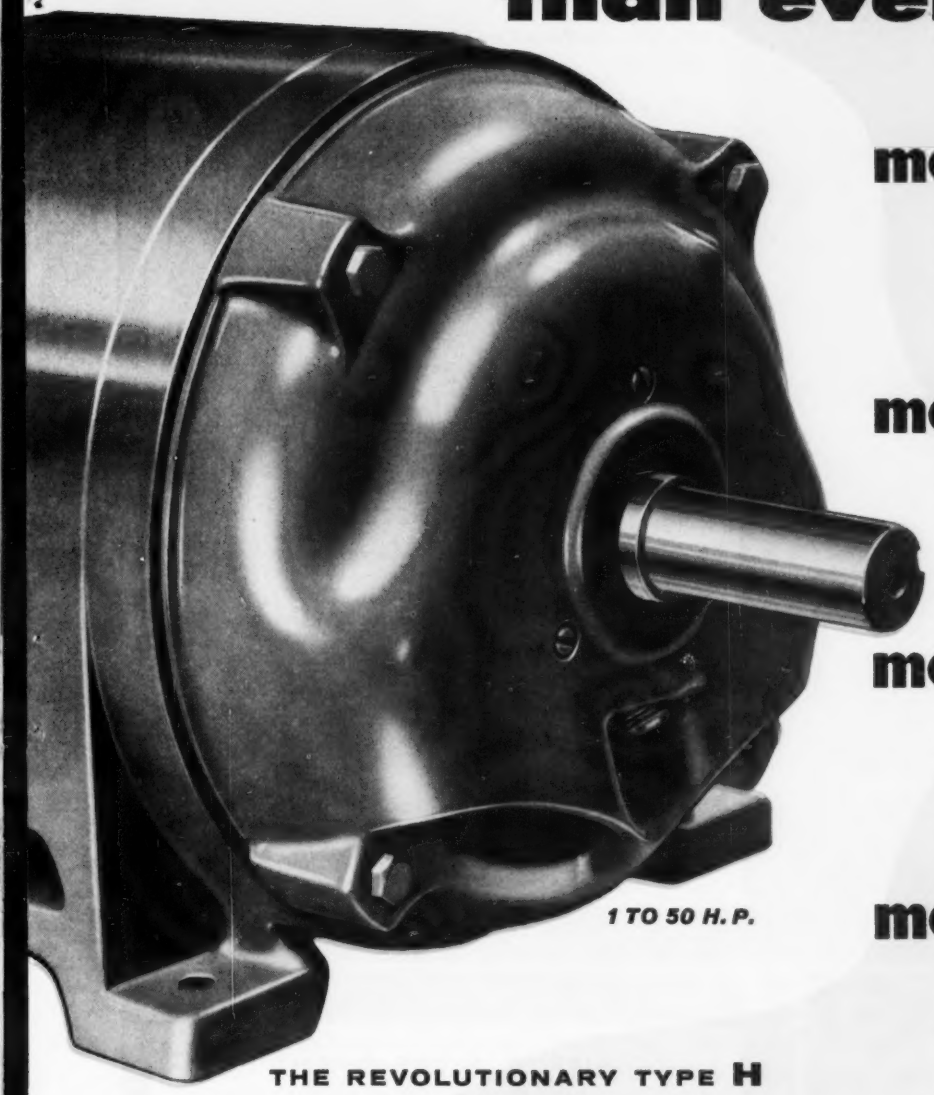
THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1207

more motor
than ever before



1 TO 50 H. P.

more LIFE

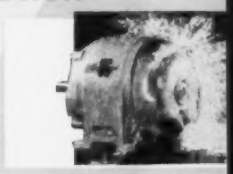
Lubriflush replaces old grease with new, for longer bearing life. Other life-lengthening features of Uniclosed are explained below.

more RUGGED

Cast-iron frame defies distortion. The smooth cast-iron surface is highly corrosion-resistant. Heavy solid feet are a substantial part of the frame.

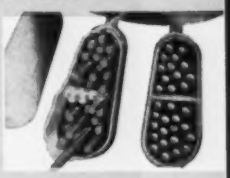
more PROTECTION

Ventrifoil directs air, deflects water. Each end of motor has specially formed deflector that directs air around bearing housings, into fans on rotor.



more INSULATION

U. S. multiple protection increases insulation life. ASBESTOS — for protection against heat. POLYESTER FILM—for greater physical strength.



more CONVENIENT

The spacious conduit box on Uniclosed Type H is heavy-duty cast-iron, diagonally split type, attractively contoured —easy of access.

THE REVOLUTIONARY TYPE H

U. S. UNICLOSED

more motor dependability is the result of more and more exclusive features: Asbestos insulation against heat and moisture; Lubriflush bearing construction for longer life; Ventrifoil baffles to direct air, deflect moisture; rugged, normalized cast iron frame . . . all Uniclosed Type H features for longer motor life, more efficient power. Write for profusely illustrated multicolor bulletin today.

MAIL COUPON NOW

U. S. ELECTRICAL MOTORS INC. P-12
P. O. Box 2058, Los Angeles 54 or Milford, Conn.

☐ *Send Uniclosed Type H Bulletin No. F-1856*

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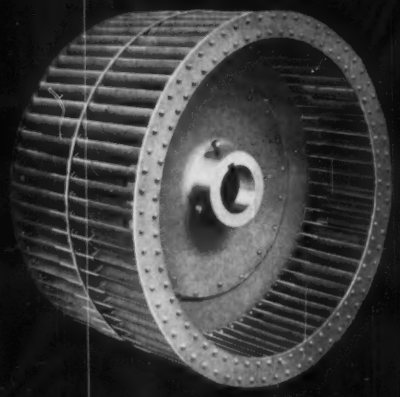
U.S. Electrical MOTORS

American Blower Fan Wheels



SIROCCO WHEELS

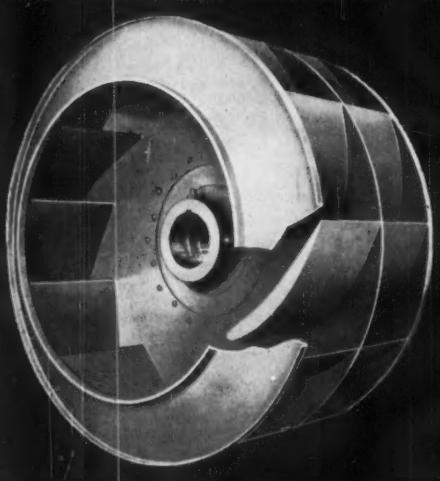
for forced and induced draft duty

- For balanced draft or pressurized furnace
- Low tip speed
- Die-formed, forwardly inclined blades and heavy streamline inlets
- Used in power plants the world over

AHS WHEELS

for forced and induced draft duty

- Backwardly inclined, nonoverloading horsepower characteristic
- For given duty operates at higher R.P.M.
- Single thickness flat or curved blade
- Heavy rolled streamline inlets

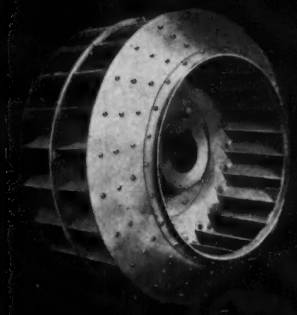


AIRFOIL BLADE WHEELS

primarily for forced draft duty

- Blades are of airfoil cross section, die formed and reinforced as required
- High mechanical and static efficiency
- Nonoverloading power characteristic
- Available with vanes and/or boxes

Meet Peak Efficiency Standards



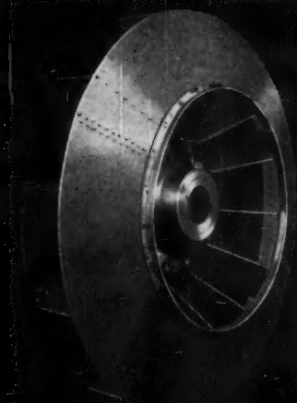
Radial tip blade wheel

RADIAL BLADE WHEELS

for forced, induced and gas recirculating duties

- Pressure characteristic favorable to gas recirculating application where unusual system pressures prevail
- Designed for severe temperature and pressure duty
- Available with straight radial or radial tip blades

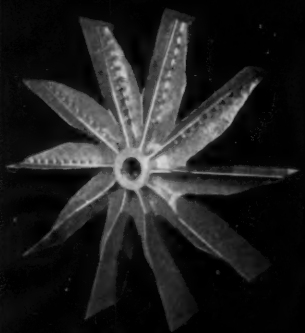
Straight radial blade wheel



Rim type wheel for primary air fans

SINGLE INLET RADIAL BLADE WHEELS FOR PRIMARY AIR, VENT, AND OVER FIRE DUTY

- Designed for high temperature, high pressure applications
- Radial or backwardly inclined blades, single inlet
- Over 1200 primary air fans in operation



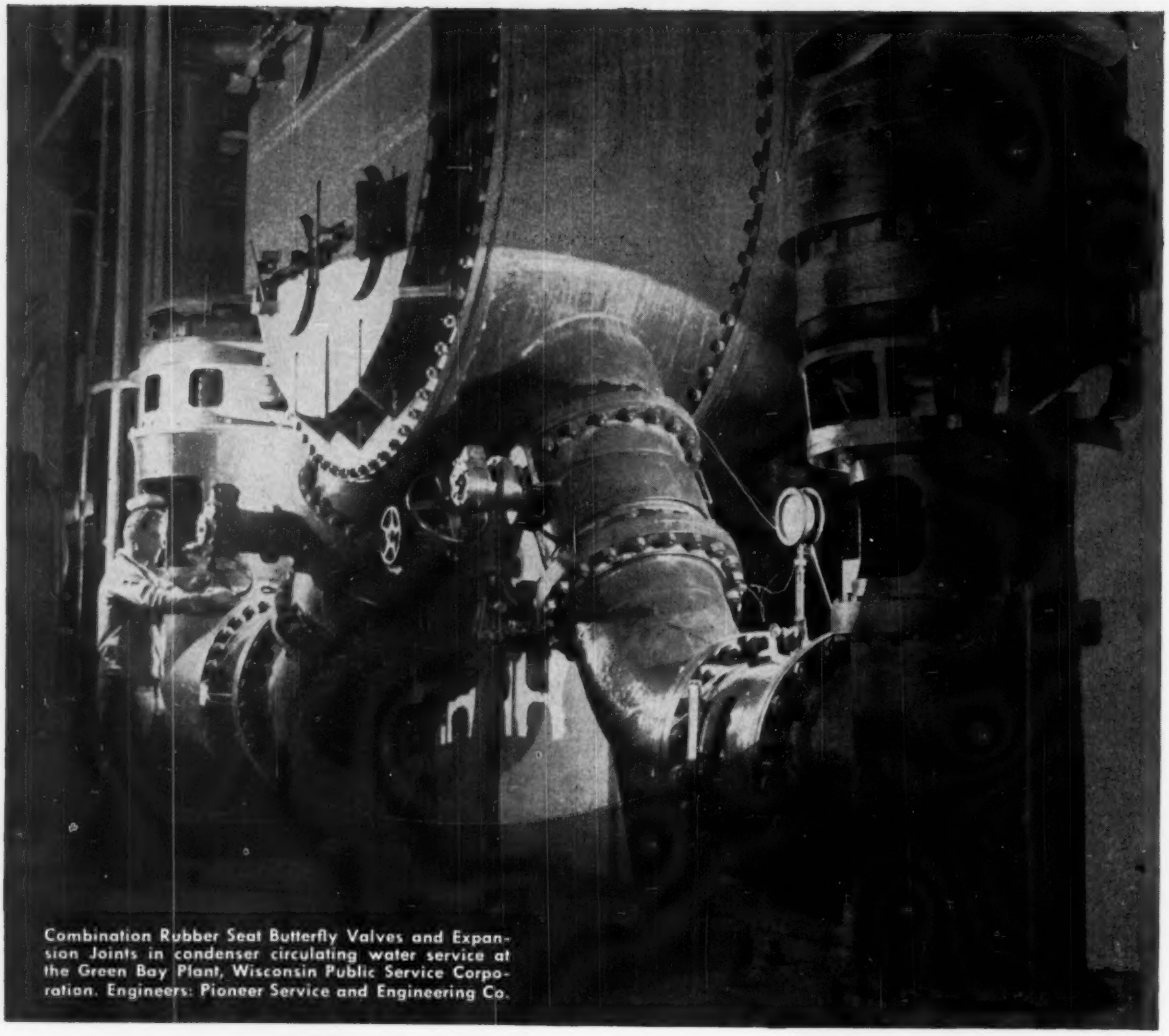
Rimless wheel for vent and over fire fans

IF YOUR plans include mechanical-draft equipment—for new installations or as replacements—consult your American Blower sales engineer. He can give you helpful information on job-fitted American Blower equipment to meet your power-plant requirements. Call our nearest branch office or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ont.

AMERICAN BLOWER

Division of AMERICAN-Standard

QUALITY PROTECTS YOUR INVESTMENT . . . AMERICAN-Standard QUALITY IS AVAILABLE AT NO EXTRA COST



Combination Rubber Seat Butterfly Valves and Expansion Joints in condenser circulating water service at the Green Bay Plant, Wisconsin Public Service Corporation. Engineers: Pioneer Service and Engineering Co.

GREEN BAY...Combines Butterfly Valves with expansion joints for new economy

Drop-tight shutoff, plus provision for pipeline expansion and ease of assembly are provided here in one compact Pratt unit. By combining the Butterfly Valve with the expansion joint, space requirements are minimized and maintenance (and initial cost) of one set of flanges and bolts is eliminated. This is a typical Henry Pratt engineering job—the mechanisms are the simplest available . . . for economy and minimum maintenance, and they are carefully designed and built for peak efficiency and operating ease.

Henry Pratt pioneered the use of Rubber Seat Butterfly Valves in power plants. Combined with permanently drop-tight shutoff, the inherent simplicity and compactness of this valve permitted a new concept of large-diameter valving by power plant engineers.

Pratt Rubber Seat Butterfly Valves grew with the Power Industry for thirty years, and today are being installed in modern, nuclear power plants. For valve design—with **imagination**—see Henry Pratt.

NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information . . . Write for Manual B-2.

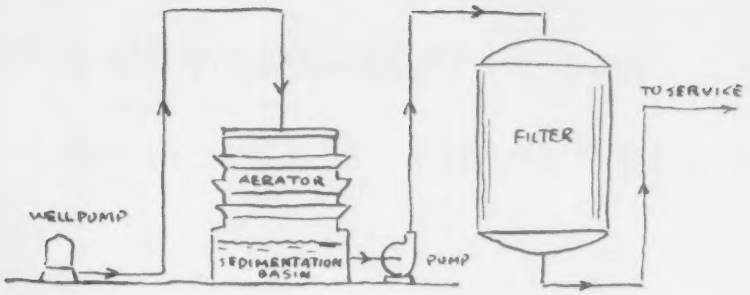
HENRY PRATT

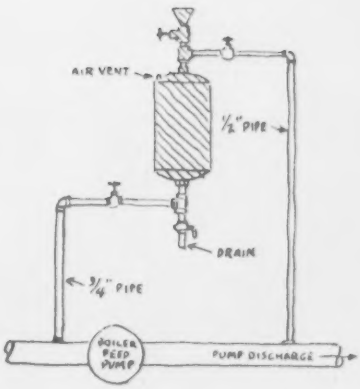
RUBBER SEAT **Butterfly Valves**

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

$$Ca^{++} + Na_2Z = CaZ + 2Na^{+}$$

347832
3.06
2086992
10434960
10643659.92

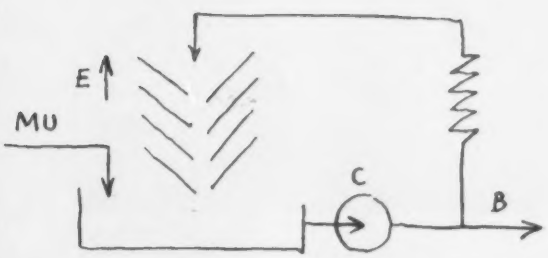




$$V = \frac{18.5D^2(S_1 - S_2)}{Z}$$

any way you figure it, the best solution to your water problems is . . .

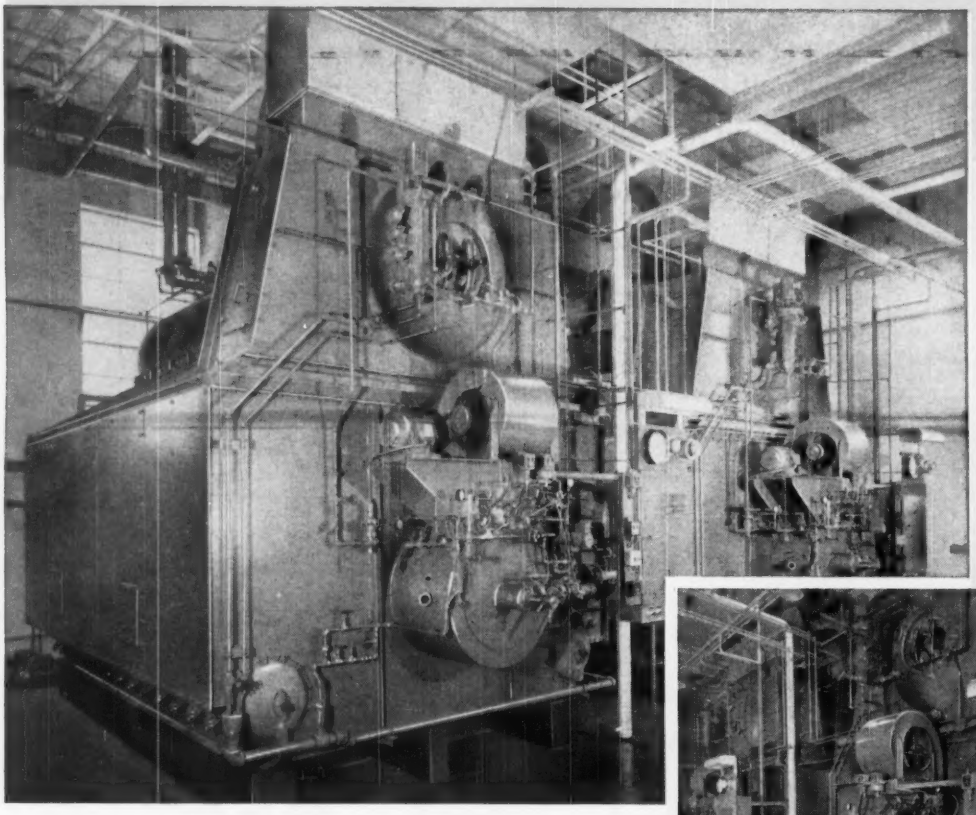
$$\frac{x}{m} = KC^{1/n}$$

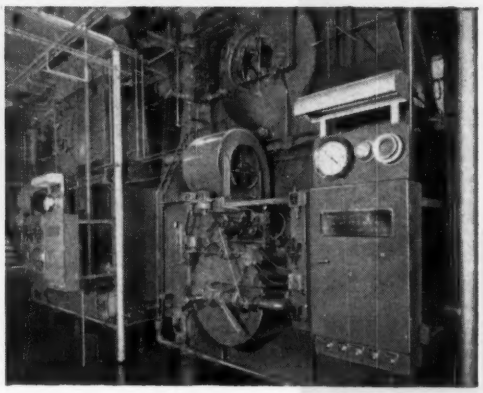


BETZ LABORATORIES INC., Philadelphia 24, Pa.

FOR UNFAILING, ECONOMICAL SERVICE,

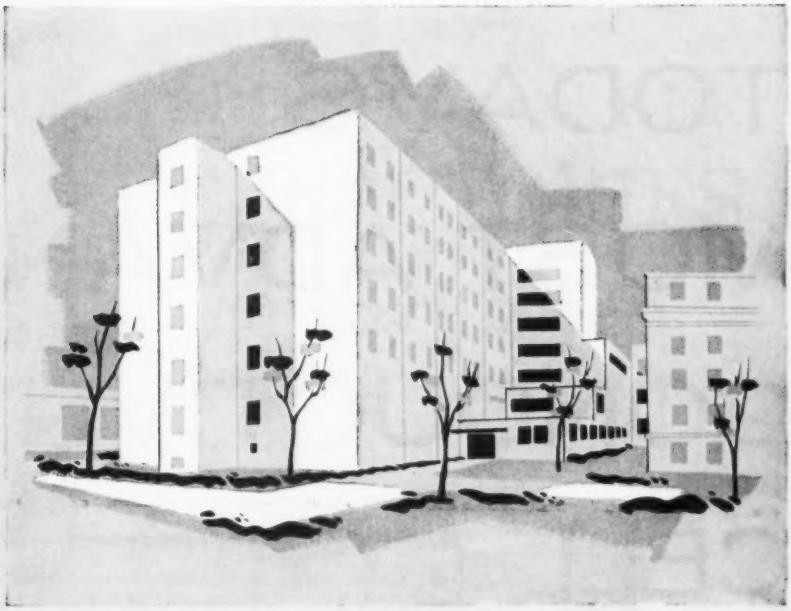
WICKES Type A, shop-assembled specified for the Edward W. Sparrow





Wickes Type-A Steam Generators combine custom engineering and shop-assembly to give you economical "packaged power" to exactly meet the load requirement. The entire unit is shipped complete ready to set on your foundation and installation can be made with minimum interruption of your production schedules. All necessary auxiliary equipment including trimmings, soot blowers, feed water regulators and other accessories, are shop-installed leaving field installation at a minimum. From the pressure-tight casing to the oil-gas burner, Wickes type-A water tube steam generators with capacities up to 60,000 lbs. of steam per hour are designed and engineered to be the standard of quality and performance in a variety of industries.

boilers are hospital



Architects sketch of new Sparrow Hospital.
Architects: O. J. Munson Associates–Lansing, Michigan.
Professional Engineers: E. Roger Hewitt Associates, Inc.–Lansing, Michigan.

One of the most important considerations in hospital construction specifications is the steam generation system, because it must give around-the-clock reliability without failure. It is significant, then, that for the Edward W. Sparrow Hospital in Lansing, Michigan, two Wickes shop-assembled Type-A Steam Generators have been installed to provide a dependable source of heat. The new units, which are housed, in a completely new boiler house, replace the original Wickes coal fired boilers. Each of these two new boilers are capable of producing 18,500 lbs. of steam per hour at an operating pressure of 125 psi. They provide 2250 square feet of heating surface and are equipped with fully automatic Wickes combination oil and gas burners. These units have a design pressure of 160 psi.

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers, and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

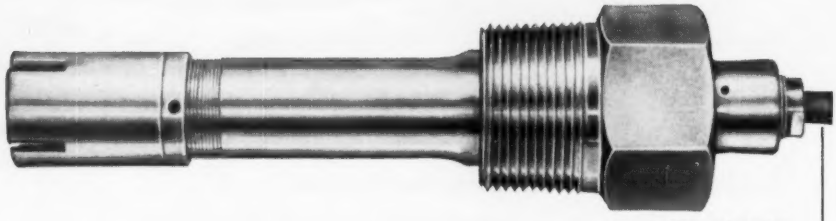
WICKES

THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • ***SALES OFFICES:*** Albuquerque, N.M. • Boston • Buffalo • Charlotte, N.C. • Chicago Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee New York City • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D.C.

TODAY'S MOST ADVANCED CONDUCTIVITY CELL



Available with valve for removing under pressure.

Exclusive Carbon Electrode Design
No Platinizing Required
Practically Maintenance-Free
Leakproof—Even at 125 psig

Here's the biggest advance in conductivity cell design in years! Foxboro Carbon Electrode Conductivity Cells now virtually eliminate cell and electrode maintenance in conductivity measurements up to 10,000 micromhos!

Foxboro Carbon Electrodes provide all the desirable surface characteristics of platinized metallic electrodes, yet require no platinization or other special coating. Cleaning, when necessary, involves simply a light brushing to keep them operating at peak efficiency. They're cased in stainless steel or brass (not glass) — you don't have to "handle with care". The electrodes are solidly anchored . . . cell constant can't change during cleaning or operation. What's more, you're sure of leak proof operation. Special "O"-ring seals and the foolproof Foxboro cable-seal protect the cell at pressures up to 125 psig — even when completely immersed.

These rugged cells, with Foxboro Dynalog* Electronic Instruments, form completely integrated systems for measurement or control . . . ideal for any industrial application. For full details write for Bulletin 19-13. **The Foxboro Company, 6812 Neponset Ave., Foxboro, Mass., U.S.A.**

DYNALOG*

Direct-Reading Conductivity Measuring Instruments

Provide unequalled accuracy, sensitivity, and speed of response for conductivity measurement and control. Dynalog stepless capacity balancing system eliminates slidewire maintenance. No standardizing necessary. 1000-cycle a.c. voltage to the conductivity cell keeps polarization effects at a minimum. Multi-Record Dynalog Instruments available for recording up to 6 different conductivity values on a single chart.

*Reg. U.S. Pat. Off.

FOXBORO
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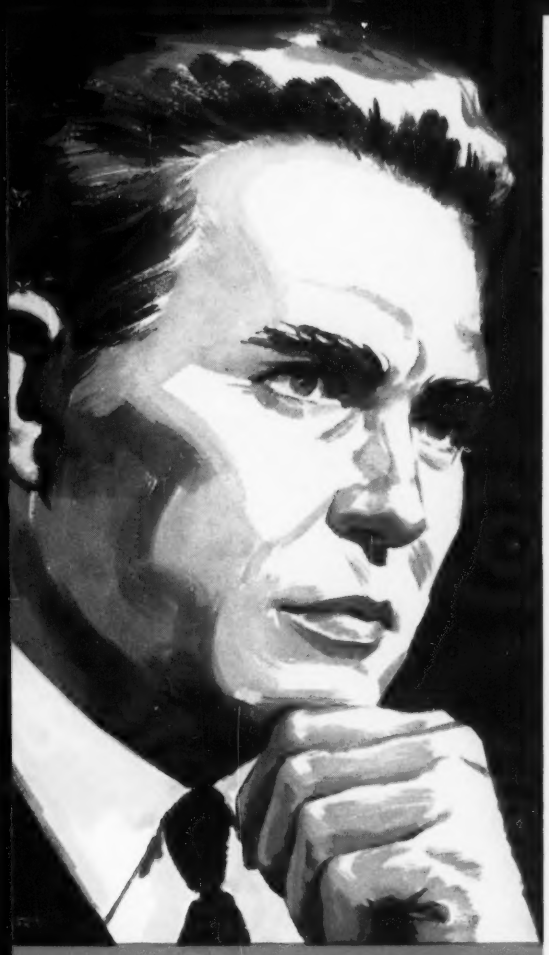
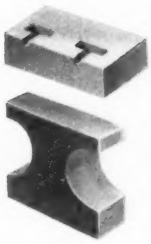
CARBON ELECTRODE CONDUCTIVITY CELLS



HARBISON-WALKER REFRACTORIES

for every boiler furnace requirement

H-W Plastic Fire Brick



Marine Boiler Anchor Tile

Baffle Tube Tile

Plastic Chrome Ore for Slag Tap Bottoms

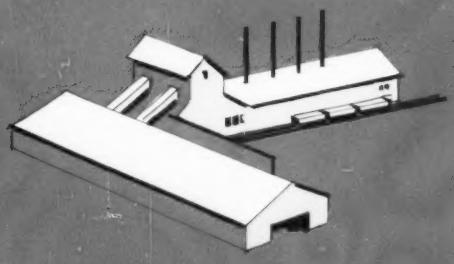
Made in all the various classes

Highly refractory cold-set mortar

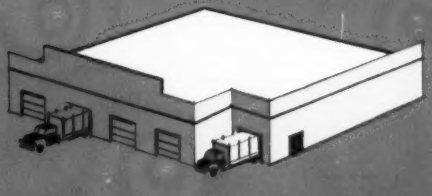
REFRACTORIES FOR ALL REQUIREMENTS

To meet the wide variety of operating conditions that exist in steam power generating plants, Harbison-Walker provides the complete range of refractories from which can be selected the exact types and brands for the most economical service.

available nearby



Harbison-Walker refractories for power plant requirements are produced in many states. Transportation time and cost advantages are obvious.



Warehouse stocks of Harbison-Walker refractories are available in many cities and towns in North America and in various other countries.

continued on next page ▷

HARBISON-WALKER
REFRACTORIES
products of highest quality, rigidly controlled

Harbison-Walker can solve your refractories problems

REFRACTORY BRICK

The various brands of Harbison-Walker refractory brick used for walls, bottoms, arches, stacks, ash pits and other services, comprise all classes of fireclay and high-alumina refractories. These provide the kinds needed in boiler settings of every type and for all fuels and operating conditions. H-W high alumina brands are especially suited for maximum resistance to the exceedingly corrosive ash of oil, coal and organic refuse, including wood waste and bagasse.

PLASTIC REFRACTORIES

Harbison-Walker plastic refractories are widely used for the construction of arches, target walls, baffle walls, burner ports and irregular shapes, as well as for making quick and economical repairs. These plastic refractories are made in both standard and super-duty classes. They are easy to install with the various H-W anchors and form durable one piece structures.

PLASTIC THERMOLITH BATCH

is a chrome refractory and because of its chemical composition and dense impervious texture when heated, gives outstanding service in bottoms of slag tap boiler furnaces.

CASTABLE REFRACTORIES

Among various kinds of Harbison-Walker castable refractories used in boiler plants with great benefit are: standard and super-duty grades, extra strength, high-alumina, chrome and lightweight classes as well as the baffle mix especially adapted for this application. The wide variety of these specialized castables provides for every particular need.

INSULATING REFRACTORIES

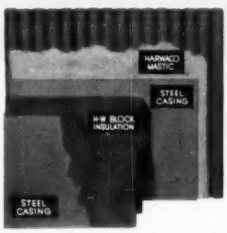
Harbison-Walker insulating fire brick are made in eight different brands, each of which is suitable for use over specific temperature ranges and various other operating conditions. Other insulating refractories are available in the form of lightweight castables, block insulation and mineral fiber coating.

MORTARS

Harbison-Walker produces both hot and cold-setting mortars of various compositions having special characteristics for the many varied applications.

HARWACO MASTIC

is a specialized product having a consistency similar to stiff putty which makes it ideally suited for plastering with a trowel as for example, in sealing the V-shaped spaces at the exterior face of tangential tubes in water-wall boilers.



Typical boiler wall construction with 1" of HARWACO MASTIC backed with a 10-gauge steel casing and superimposed H-W BLOCK INSULATION

see other side

Technical service based on the most extensive experience and research is freely offered for assistance in determining the refractories best suited for each specific requirement.

World's most complete refractories service

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
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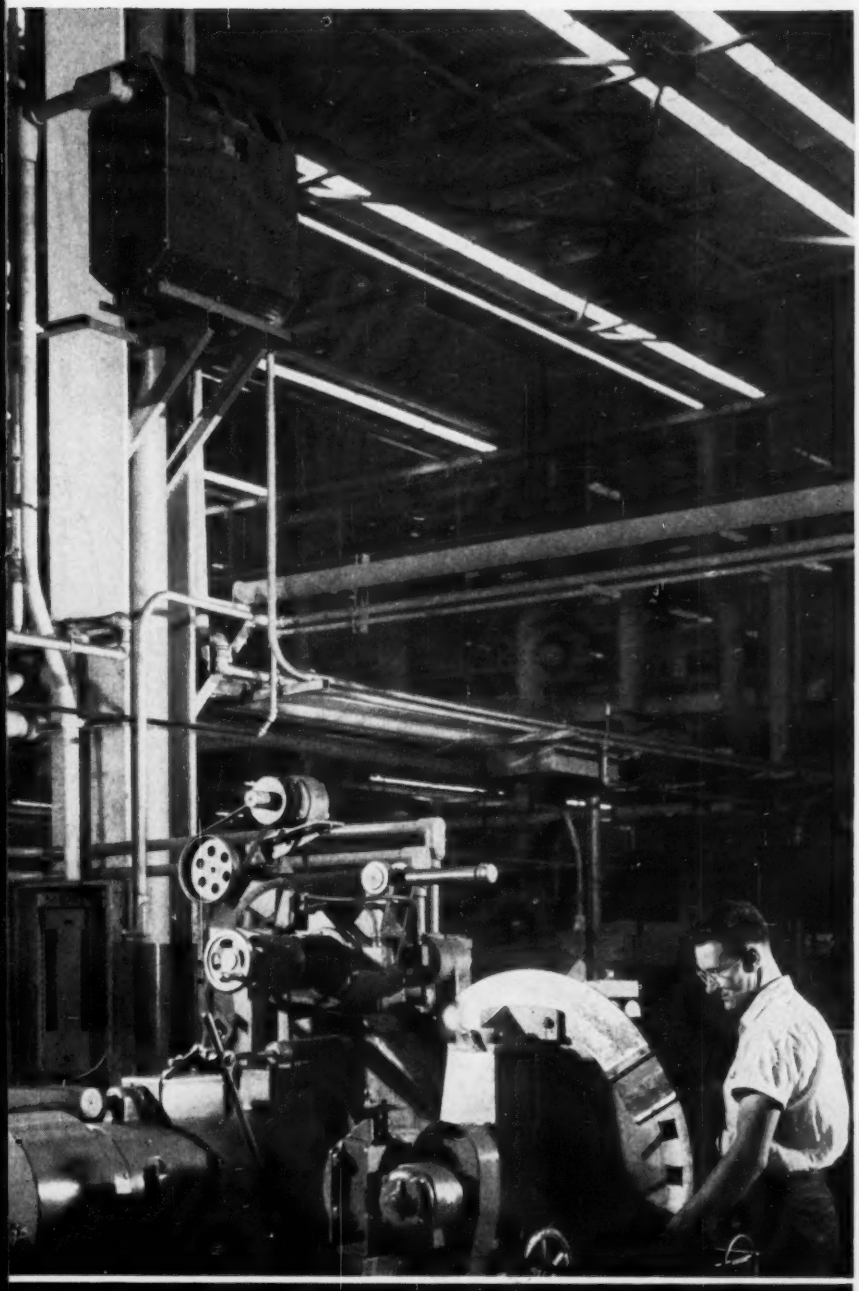
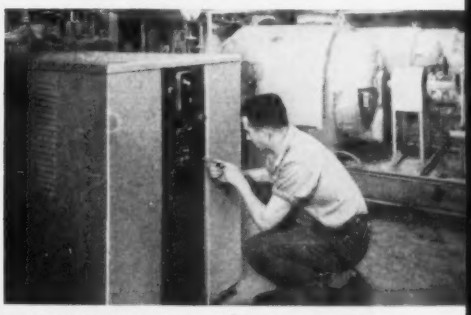
ECONOMICAL

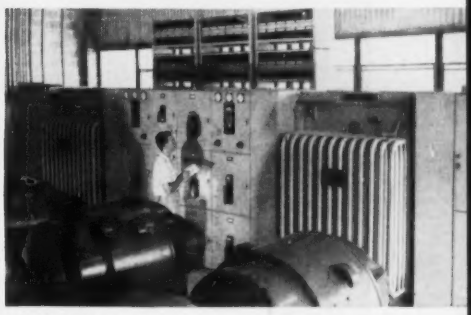
PLAN A COMBINED LIGHT AND POWER SYSTEM FOR SUBSTANTIAL SAVINGS, GREATER ADAPTABILITY



Serving power and lighting loads from one regulated substation offers large savings. Compared with 120Y/208-v systems, G-E 480Y/277-v systems use less-metal circuits. When load areas also need 120- or 240-volt power, economical dry-type transformers can provide it. Result: savings in copper and dollars. Contact your G-E Apparatus Sales Office or send coupon for help in your distribution system planning.



ECONOMICAL Inductrol® voltage regulator provides precise, automatic control of low-voltage loads in power systems at all times.



ECONOMICAL G-E load center system lowers first costs, voltage drop. Capacitor equipments improve power factor, cut costs.

GENERAL ELECTRIC

To help make your plant's power distribution system

● ECONOMICAL ● EXPANSIBLE ● SAFE
● RELIABLE ● FLEXIBLE

Write to General Electric Co., Section B680-10, Schenectady 5, N. Y. for:

- ☐ "Combined Light and Power Systems," bulletin GET-1337B
- ☐ Information on color movie, "Goodbye Steve," the industrial power story.
- ☐ Inductrol Voltage Regulator, GEC-1450

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COMPANY_____

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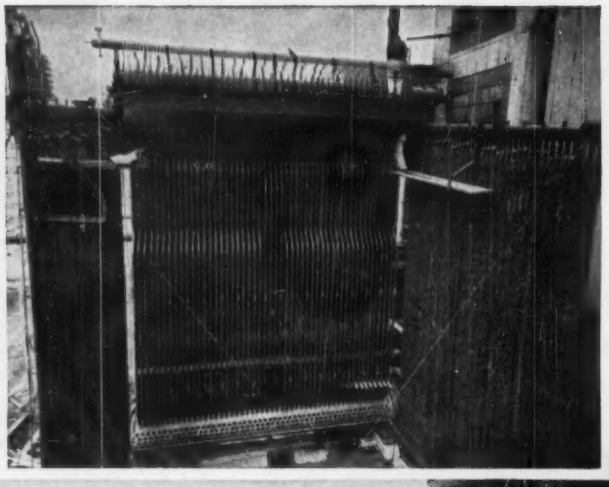
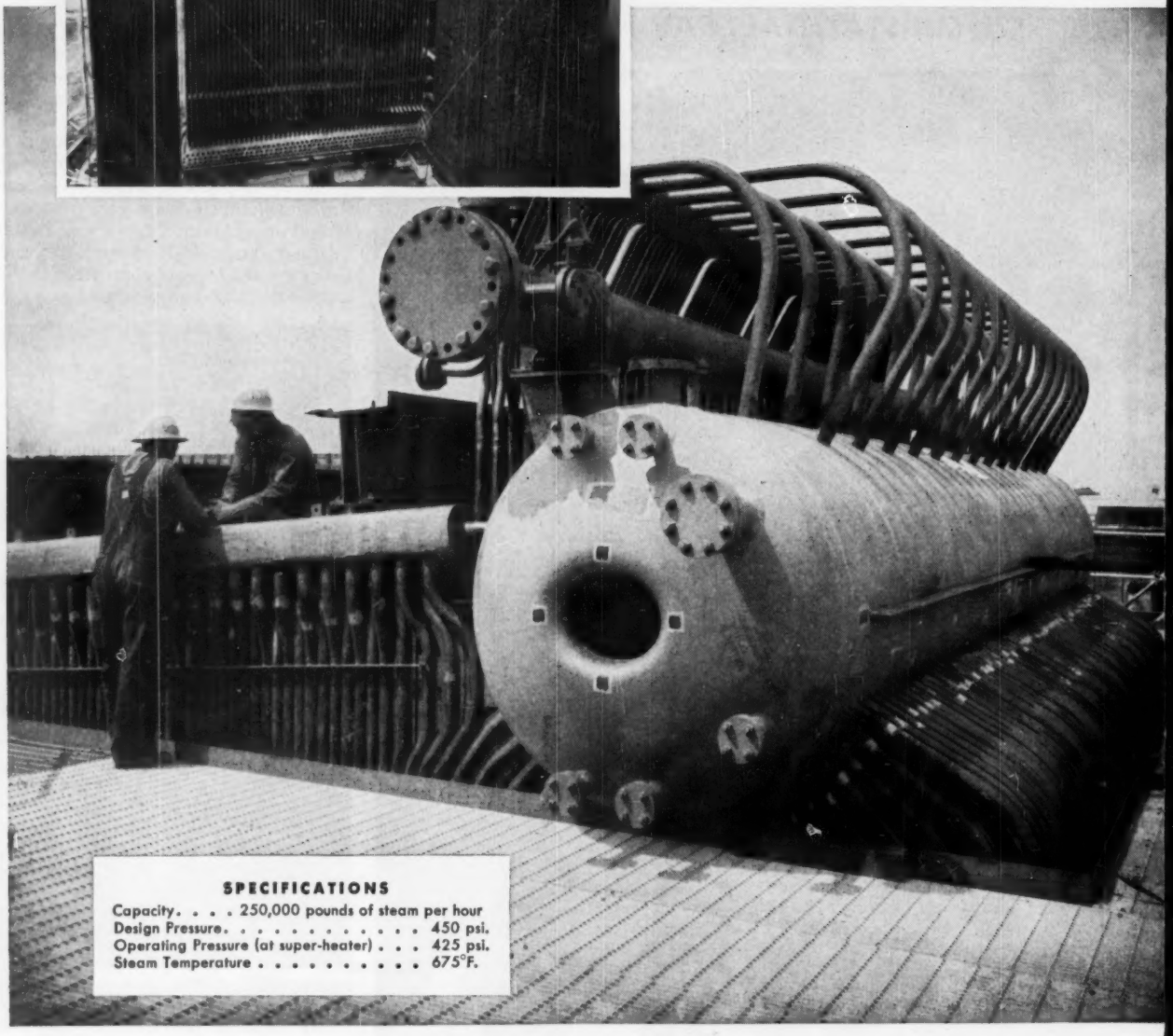
Republic





SPECIFICATIONS

Capacity	250,000 pounds of steam per hour
Design Pressure	450 psi.
Operating Pressure (at super-heater)	425 psi.
Steam Temperature	675°F.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

ELECTRUNITE Boiler Tubes

speed installation, assure top performance

"In Service on Time"! That is the target of Combustion Engineering, Inc., general boiler designers and erectors now working on the construction of a new boiler installation for the Magnolia Petroleum Company at Beaumont, Texas.

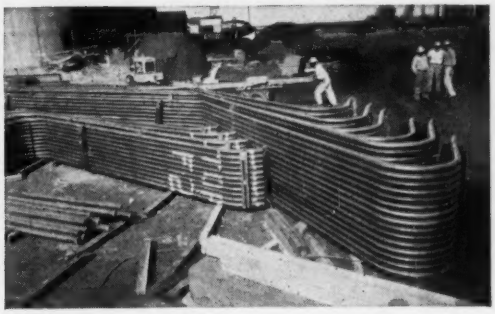
And past performance-records indicate Combustion Engineering will make this target, too, aided by the reliability, dependability, workability of Republic ELECTRUNITE® Boiler Tubes.

This Magnolia Petroleum Company installation has a design pressure of 450 psi., operating at 425 psi. at superheater outlet with a total temperature of 675°F., 250,000 pounds of steam per hour. Republic ELECTRUNITE meets every job requirement.

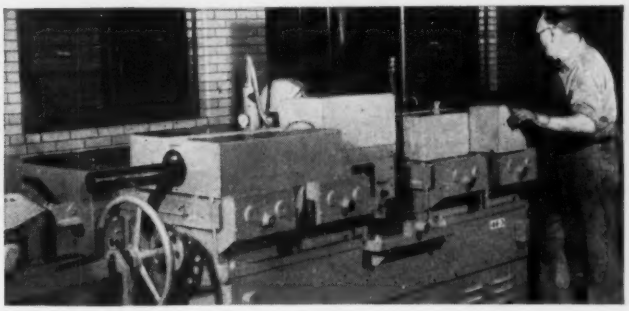
Each length of Republic ELECTRUNITE Boiler Tubing is hydrostatically or electronically tested to conform to the applicable ASTM specifications and the requirements of the ASME Boiler and Pressure Vessel Code, as well as local, state, and boiler-insurance requirements. In addition, Republic ELECTRUNITE is approved on an equal basis with tubes made by any other process up to 850°F. It is available for pressures over 2000 psi. in various sizes and wall thicknesses.

That is why more and more Republic ELECTRUNITE Boiler Tubing is specified by designers, engineers, and erectors for vital steam generating units operating in every industry and community field.

Your local Republic representative will be happy to supply you with all the facts on Republic ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubing. Call today, or send coupon for literature.



Uniform ductility of Republic ELECTRUNITE Tubing makes bending to a precise contour easy. These units have been tack welded, shipped, are ready for final installation. Saves time in handling, transportation and erection.



SPECIFY FARROWTEST® — the most conclusive, nondestructive electronic tubing test in use today. Developed by Republic, FARROWTEST provides detector coils that can electronically spot defects in tube walls which would be hidden from routine test procedures.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. C-4312R
3144 EAST 45th STREET, CLEVELAND 27, OHIO

Please send the following literature:

- ☐ Illustrated booklet giving facts on ELECTRUNITE Boiler Tubes
- ☐ Eight-page brochure on ELECTRUNITE Heat Exchanger Tubing
  - ☐ Carbon Steel ☐ Stainless Steel
- ☐ Handy wall chart on care and maintenance of boiler tubes
- ☐ FARROWTEST brochure

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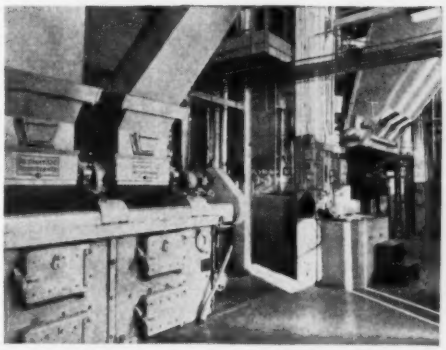
Carlisle Tire
CARLISLE TIRE &

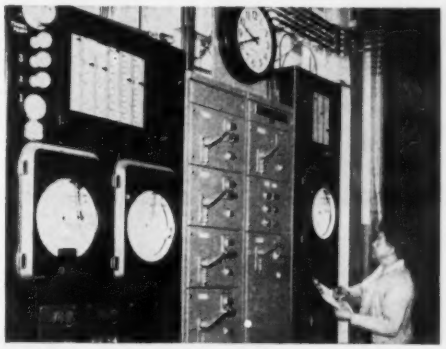
takes fuel costs for a ride

With increased fuel efficiency, Carlisle Tire and Rubber burns coal . . . holds costs to minimum while upping production 20%

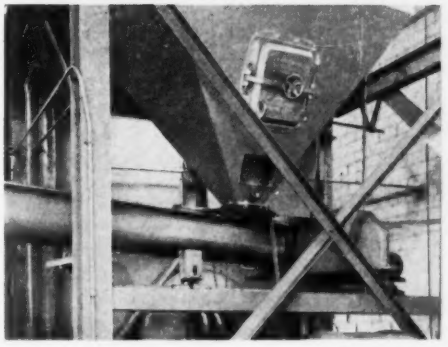
At the Carlisle Tire and Rubber Division of Carlisle Corp., Carlisle, Pa., the steam produced by the power plant is used primarily for processing. As production of bicycle tires, inner tubes and other rubber products increased, the firm's engineering department decided to boost steam capacity with modern coal-burning facilities. Coal was used on the basis of cost—25% less than the nearest competitive fuel. The result has been a dependable steam supply, cleanliness of operation and a jump in operating efficiency. Today the plant consumes the same tonnage of coal as before modernization although production has increased 20%!



Firing aisle of Carlisle's power plant. Left foreground is new 20,000 lbs./hr. boiler by E. Keeler Co., fired by Detroit Rotostokers. In the rear is an Erie City Water Tube Boiler (equipped with Erie City Spreader Stokers), used as stand-by unit.



Close-up of control panel, by Hagan Corp. These controls—regulating furnace draft, steam flow, air flow, flue gas temperature, stoker control—constitute a complete, automatic combustion control system.



Fly ash is collected by this Prat-Daniel Mechanical Precipitator. Fly ash is gravity-fed from the hopper (at top of photograph) into completely-enclosed screw conveyor which moves it cleanly to the disposal point.

Facts you should know about coal

Not only is bituminous coal the lowest-cost fuel in most industrial areas, as in the case of Carlisle, but up-to-date coal burning equipment can give you 10% to 40% more steam per dollar on the average. Today's automatic equipment pares labor costs and eliminates smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

The Bituminous Coal Institute offers a free technical advisory service on industrial fuel problems. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send the coupon below for our case history booklet, complete with data sheets. You'll find it informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—will effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

Southern Building • Washington 5, D.C.

The Bituminous Coal Institute now has available a free booklet, "Guide Specifications for Typical Low-Pressure Commercial Heating Plant," containing specifications, drawings and tables on all aspects of a typical heating plant. Send in this coupon for your copy.

Please send me: ☐ Guide Specifications booklet ☐ Case history booklet

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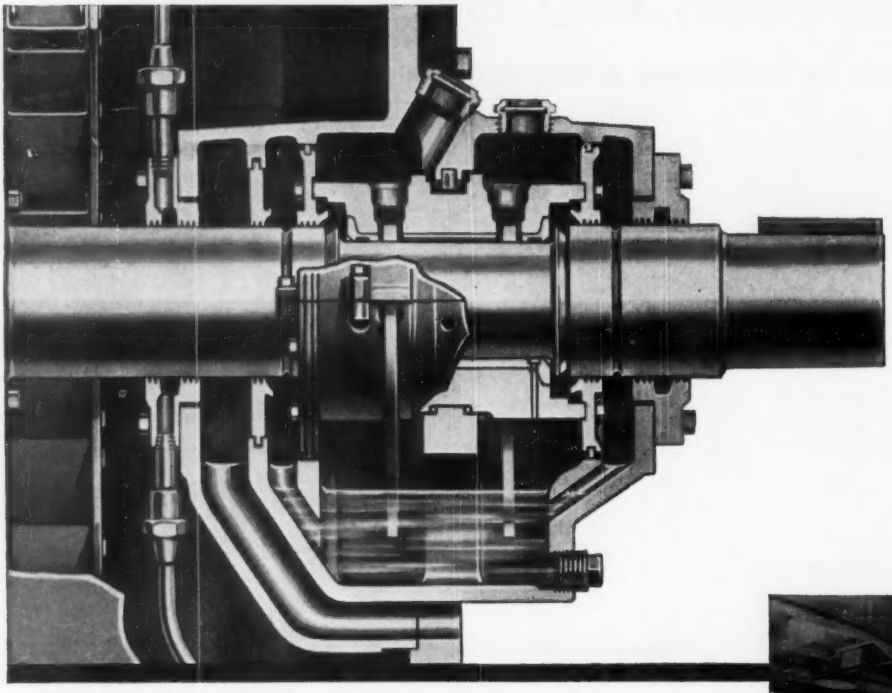
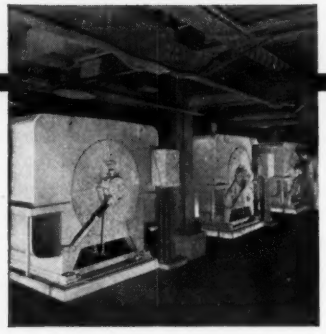
One of many reasons why **ALLIS-CHALMERS MOTORS**
operate dependably for

POWER PLANTS





Allis-Chalmers 1750-hp weather-protected motors driving boiler feed pumps.

Motor Bearing is "extra sealed" with vent

A VENT is seldom a seal . . . but it is in this high speed Allis-Chalmers motor.

Just in case any oil or oil vapor might pass out of the bearing enclosure through the regular seals it can never reach the motor interior. Instead, it enters an annular chamber at the rear of the bearing housing. Pressurized air from the motor fan region is introduced into this pressure chamber and is vented to atmosphere. Positive protection is provided.

Accessible, Too!

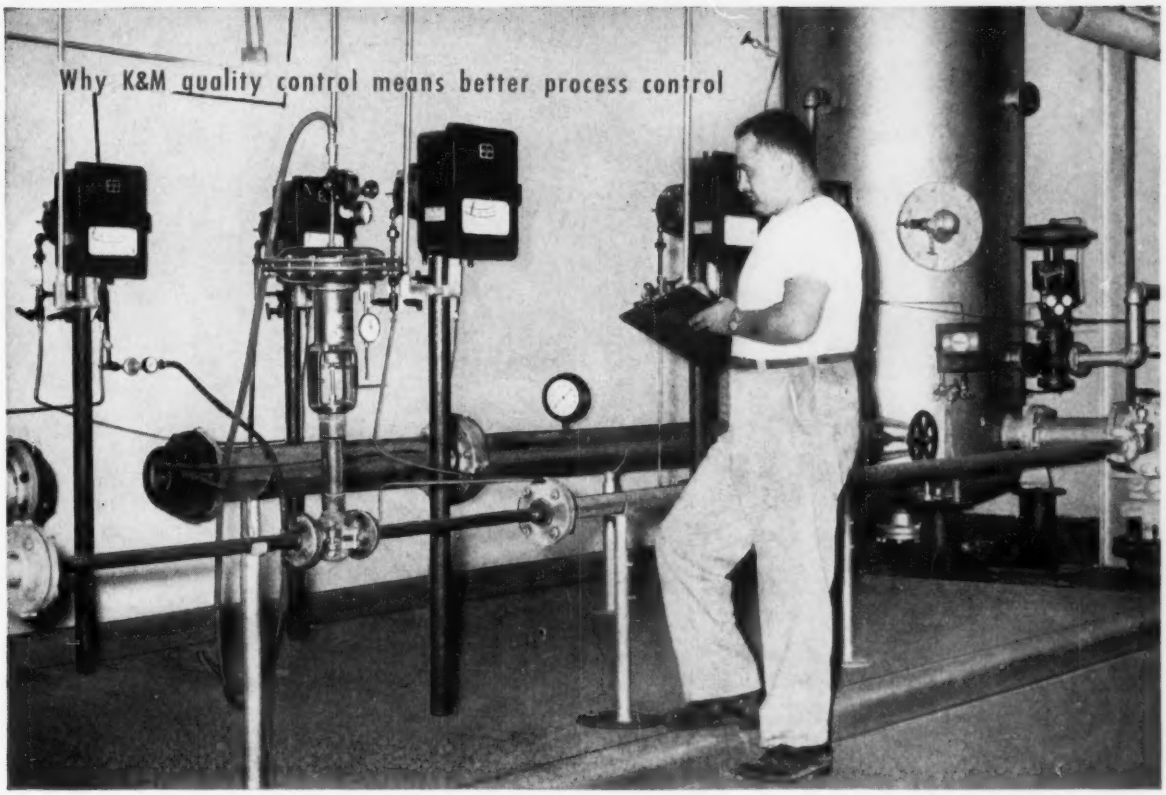
Many man-hours in maintenance are saved because the motor can be inspected and maintained without opening or disturbing the bearing itself. It is only necessary to remove the upper half of the split end shield.

For details on these and other features of Allis-Chalmers motors, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

ALLIS CHALMERS

A-5477



ANY FLOW...0 to 4000 GPM

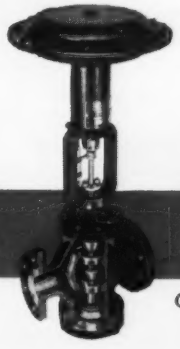
K&M's new lab provides accurate data for more precise valve specifications

Thorough testing under simulated on-stream conditions enables K&M to give you *realistic* valve performance specifications . . . *reliable* data based on actual observation. No guesswork . . . no maybe's.

At K&M's newly enlarged fluid dynamics lab, engineers can take simultaneous flow and pressure-drop readings at any desired flow rate up to 4000 GPM, under pressure heads of up to 225 ft. of water. In-the-line response characteristics are thus made accurately predictable.

The flow test laboratory is but one part of a continually expanding quality control program that now includes radiographic inspection, high-temperature leak testing and spectrometric analysis of critical valve assemblies.

When it comes to fluid control, why don't you, too, come to K&M . . . where the highest standard of workmanship is always an unwritten specification.



K&M

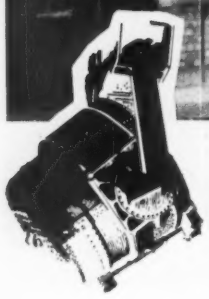
diaphragm control valves

Our 78th Year

KIELEY & MUELLER, INCORPORATED

Oldest Pressure and Level Control Valve Manufacturer

64 Genung Street, Middletown, New York



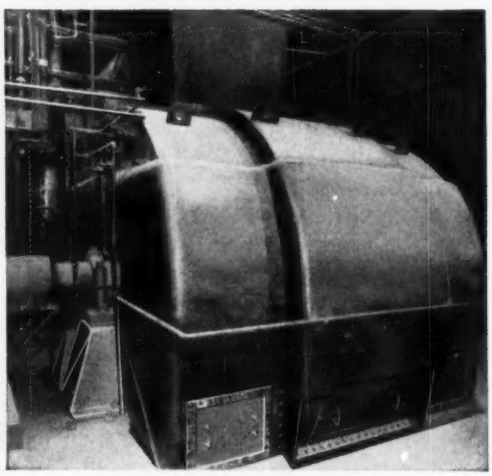
World's largest open hearth furnace utilizes Clarage Fans

600 TONS— enough steel in each heat for 300 automobiles. That's the capacity of Weirton Steel Company's new open hearth furnace at Weirton, W. Va. Weirton Steel is a division of National Steel Corporation.

Designed and built by Loftus Engineering Corporation, Gateway Center, Pittsburgh, this giant is completely automatic in operation.

As for so many other impressive installations, Clarage equipment was selected — a Clarage induced draft fan for the waste heat boiler and a Clarage forced draft fan for the furnace.

Investigate the advantages Clarage equipment offers for YOUR mechanical draft installations. Contact our nearest sales engineering office or write us for complete literature. CLARAGE FAN COMPANY, Kalamazoo, Michigan.



Clarage heavy-duty fan provides induced draft for waste heat boiler.

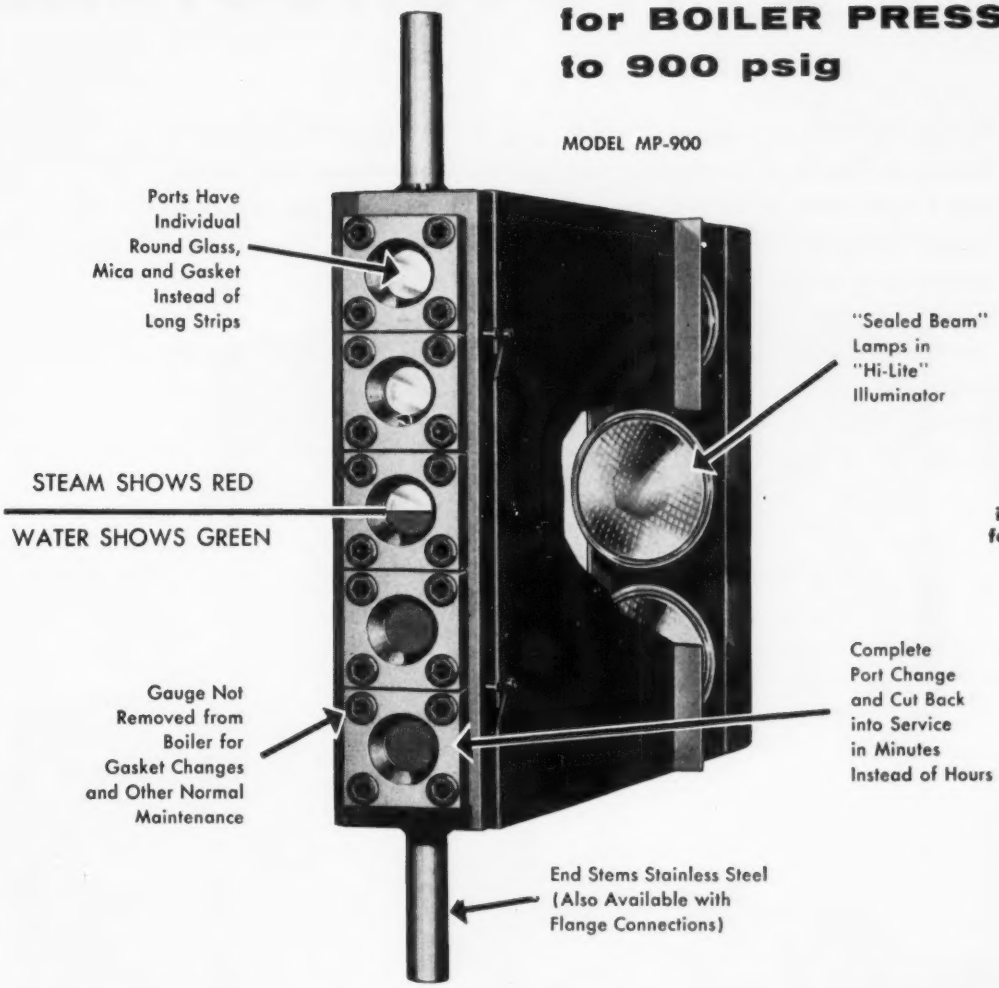
CLARAGE ... dependable equipment for making air your servant

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

Sure-Reading ...DIAMOND "Multi-Port" Bi-Color Gauge

for BOILER PRESSURES to 900 psig

MODEL MP-900


Ports Have Individual Round Glass, Mica and Gasket Instead of Long Strips
"Sealed Beam" Lamps in "Hi-Lite" Illuminator
STEAM SHOWS RED
WATER SHOWS GREEN
Also available is Model MP-3000 for boiler pressures to 3000 psig
Complete Port Change and Cut Back into Service in Minutes Instead of Hours
Gauge Not Removed from Boiler for Gasket Changes and Other Normal Maintenance
End Stems Stainless Steel (Also Available with Flange Connections)

The individual round ports each having its own round glass, round mica and round gasket (instead of the conventional long strips) means less stress and strain . . . resulting in greatly reduced maintenance. When replacement is required, it is usually only one port . . . which can be changed in a very few minutes . . . and without removing the gauge from the boiler.

The Diamond Bi-Color feature is another important advantage of the MP-900 Multi-Port . . . steam always shows red and water always shows green. There can be no question of the water level.

Recommended for both new and old boilers up to 900 psig, the MP-900 Multi-Port will give you a new standard of gauge operation. Use the coupon below for additional information.

7757

DIAMOND POWER SPECIALTY CORP. U
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 2044 explaining the advantages of the Diamond MP-900 "MULTI-PORT" Bi-Color Gauge for all boiler operating pressures up to 900 psig.

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DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

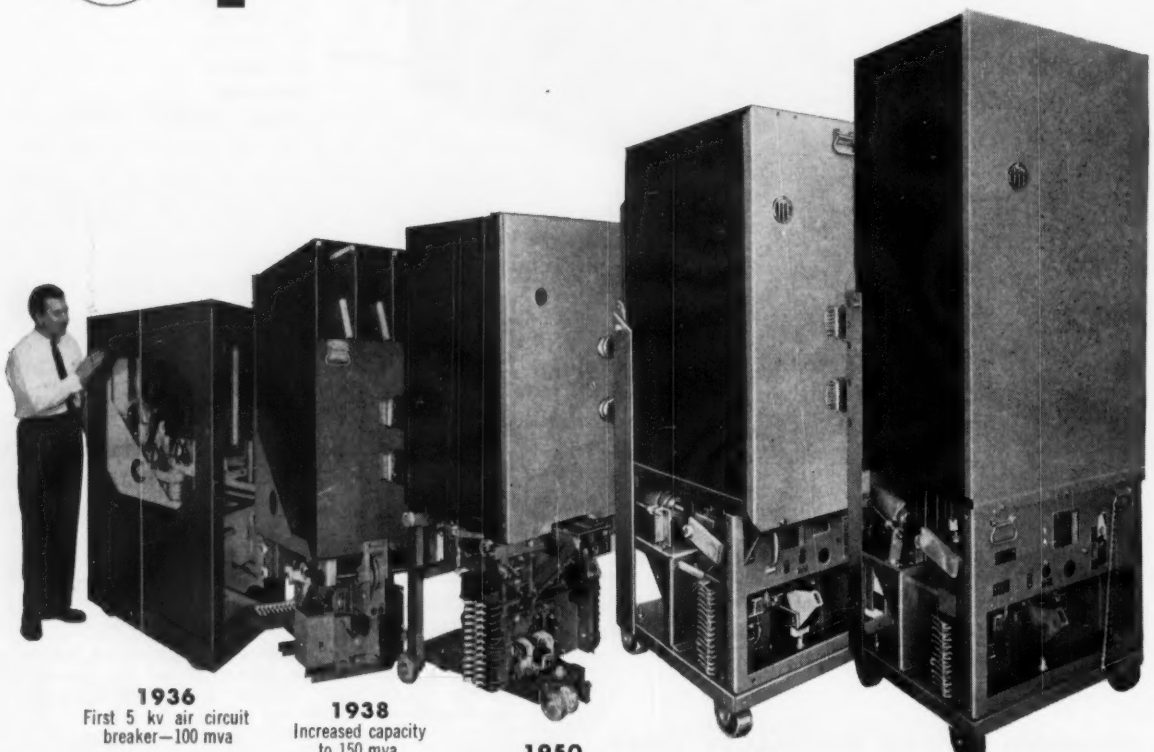
I-T-E...Pioneer in

In 1936, I-T-E introduced the first 5 kv magnetic air circuit breaker and it has led the field in development of this type of equipment ever since. In the past 4 years alone, it has extended its line of 5 kv metal-clad switchgear to include the first 350 mva interrupting capacity air breaker and its line of 15 kv metal-clad switchgear to include the first 1000 mva air breaker.

Get complete information on all I-T-E high voltage magnetic air circuit breakers. Call our nearest sales office today for it. Or write Switchgear Division, I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

SWITCHGEAR DIVISION

I-T-E CIRCUIT BREAKER COMPANY



1936
First 5 kv air circuit breaker—100 mva

1938
Increased capacity to 150 mva

1950
Reached 250 mva rating

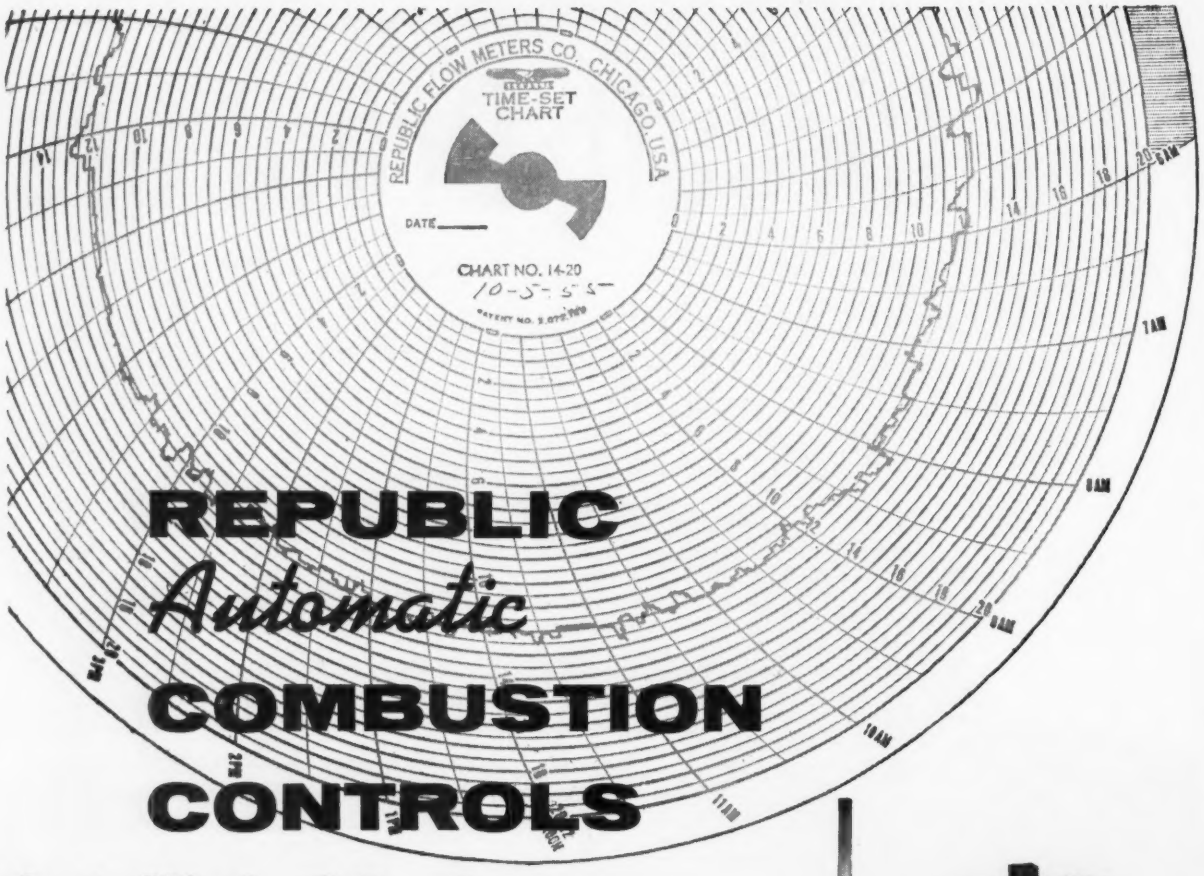
1954
Brought out 15 kv air circuit breaker

1956
350 mva in 5 kv class

Air Circuit Breakers

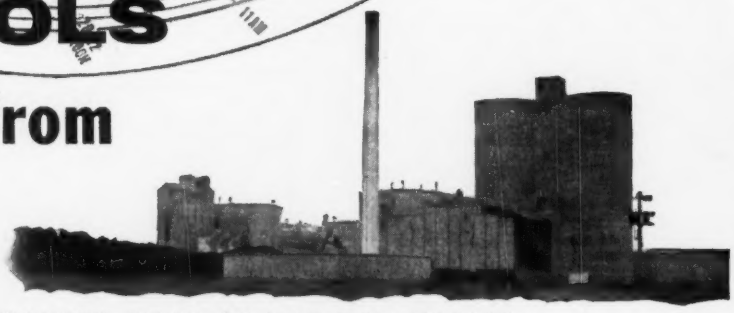
1956
750 mva in 15 kv class

1957
Now the 1000 mva
15 kv circuit breaker



REPUBLIC *Automatic* COMBUSTION CONTROLS

Get High CO_2 from Low Grade Coal



at UTAH-IDAHO SUGAR COMPANY'S NEW $7,000,000 PLANT

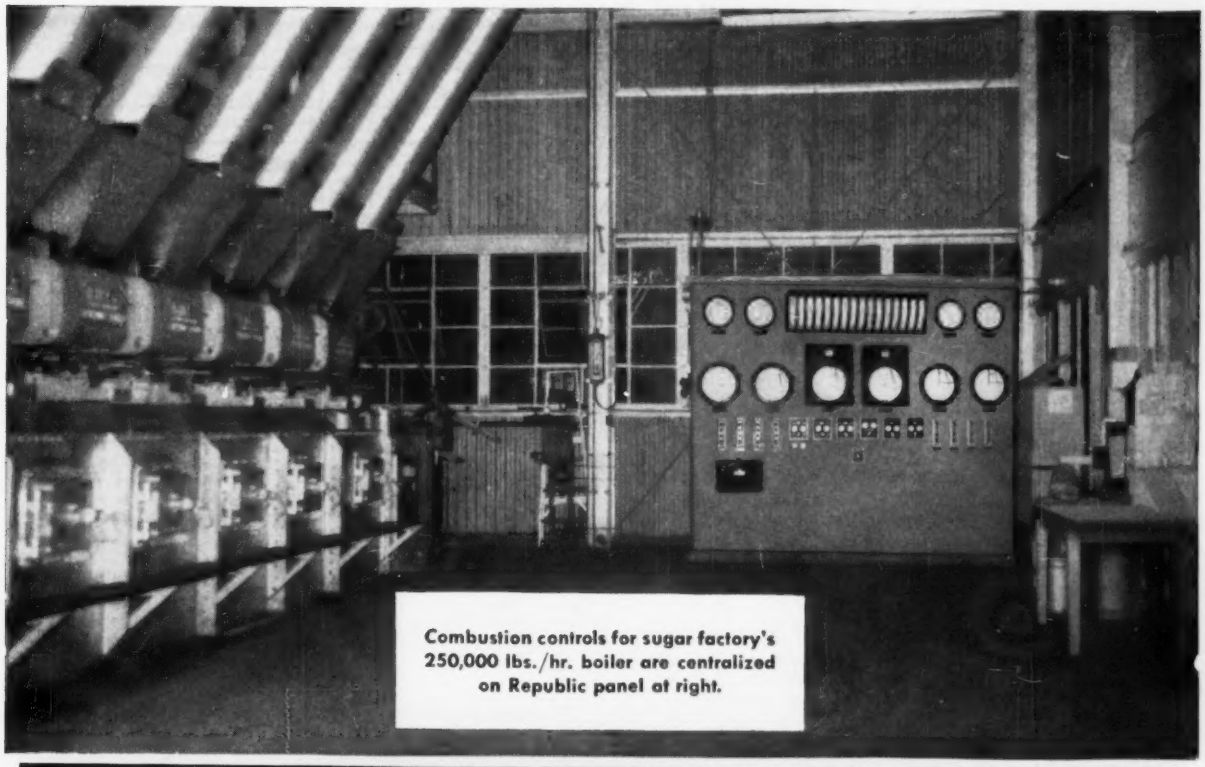
In any power plant, the percentage of CO_2 in combustion gases is indicative of combustion efficiency. But at the power plant for Utah-Idaho Sugar Company's new sugar beet factory, Moses Lake, Washington, a good CO_2 performance record is more than desirable. It's actually essential! That's because the plant supplies not only steam, but CO_2 as well to sugar-making processes. The CO_2 is extracted from combustion gases and becomes a vital ingredient in the production of over 75,000,000 lbs. of sugar and thousands of tons of molasses the factory produces annually. With the plant limited to low grade western coal, continuous maximum combustion efficiency at all loads is necessary to insure adequate CO_2 for processes.

Republic Automatic Combustion Controls enable the plant's spread stoker fired 250,000 lbs./hr. boiler

operating at 400 psig and 575°F. to meet CO_2 requirements while matching steam supply to process demands. Daily CO_2 charts indicate the boiler is consistently producing 12–13% CO_2 in spite of the quality of coal burned.

According to operators, ash removal, cleaning of the fire and soot blowing can be carried out with the combustion controls on automatic without disturbing the fuel-air ratio. Furnace draft is controlled satisfactorily despite the high stack on the plant. Turbine drives on forced and induced draft fans are speed controlled by the combustion controls, eliminating the need for dampers. A three element Republic boiler feedwater system is also tied in with the combustion control system to automatically supply the proper amount of water to the boiler at all steaming rates.

This plant is one more example of how Republic combustion engineers design control systems that enable boilers to exactly meet individual plant requirements. There are Republic Combustion Controls for any size or type of boiler, for all methods of fuel firing, all arrangements of draft and all load conditions. When you want to be sure of getting maximum boiler performance, ask Republic to design and build your combustion control system.



Combustion controls for sugar factory's 250,000 lbs./hr. boiler are centralized on Republic panel at right.

REPUBLIC FLOW METERS CO.

A Subsidiary of Rockwell Manufacturing Company

2240 Diversey Parkway • Chicago 47, Illinois

Kaiser Aluminum sheet for jacketing offers new economies through improved application methods

Recent developments make possible new low costs for the power, refinery and chemical industries

As you can see in the relative cost charts at the right, aluminum sheet jacketing now offers the *lowest first cost* of four well-known finishing methods for pipe insulation . . . and it offers *lower first cost* than wet-construction finishing methods for vessel insulation.

Another important fact, not revealed in the charts, is that aluminum's first cost is becoming *increasingly* competitive, thanks to newly-developed methods that speed application and reduce labor costs!

And if maintenance costs were added to the comparisons, aluminum would present an *even better value*—because only aluminum eliminates maintenance.* Its remarkable resistance to corrosion eliminates the need for painting . . . even when exposed to weather and mechanical abuse.

New Dry Wall Construction for Vessels

A number of improvements in application technique—developed by Kaiser Aluminum engineers in cooperation with specialists from various industries—adapt dry-wall type construction to the finishing of large cylindrical and flat insulated surfaces. These techniques virtually eliminate the need for costly application methods used to apply wet materials such as insulating cements, emulsions, mastics, adhesives, glue sizing and paint. Where corrugated aluminum sheets are used, positioning and fastening are simplified and speeded by familiar techniques employed for block insulations.

New "Snap-Back" Aluminum Jacketing Speeds Installation on Piping

Aluminum's unique advantages in light weight and superior workability have made possible greatly simplified preformed "snap" jackets for quick, easy application on piping.

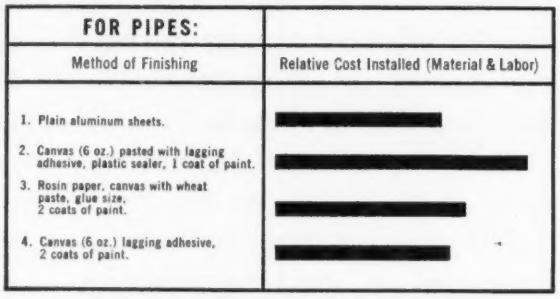
Jacketing, preformed into undersize tubes from stiff sheets of aluminum, will snap back to a tight fit when placed over pipe insulation, freeing both hands for fastening. This tight fit requires less fasteners per running foot.

The following is an outline discussion of important factors in aluminum jacketing materials and alloys, with suggested application methods best suited to various insulated surfaces, including pipes, vessels, vessel heads and others.

The Jacketing Alloys

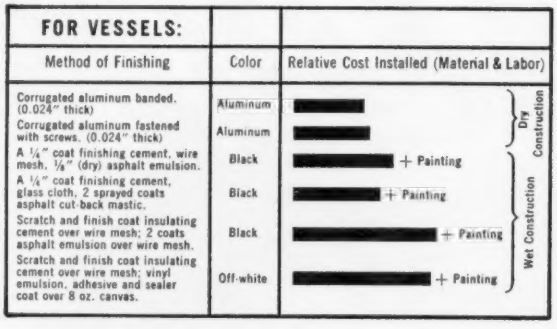
The following aluminum alloys, supplied in flat or coiled sheets, are successfully used for insulation jacketing: 1100, 3003, 3004, 5005, 5050, 5052, Kaiser Aluminum industrial roofing and siding alloy, and Kaiser Aluminum standard roofing alloy.

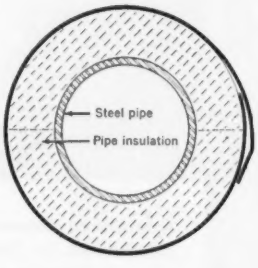
*Roofing felt has a lower initial cost than aluminum, but painting and maintenance offset this initial cost advantage.


FOR PIPES:
Method of Finishing
Relative Cost Installed (Material & Labor)
1. Plain aluminum sheets.
2. Canvas (6 oz.) pasted with lagging adhesive, plastic sealer, 1 coat of paint.
3. Rosin paper, canvas with wheat paste, glue size, 2 coats of paint.
4. Canvas (6 oz.) lagging adhesive, 2 coats of paint.

Results of first cost analyses of various insulation finishes

NOTE: Charts show first costs only. To arrive at total costs, maintenance costs must be added. Whereas other finishing methods require frequent and costly maintenance, aluminum jacketing is virtually maintenance-free.


FOR VESSELS:
Method of Finishing
Color
Relative Cost Installed (Material & Labor)
Corrugated aluminum banded. (0.024" thick)
Aluminum
Corrugated aluminum fastened with screws. (0.024" thick)
Aluminum
Dry Construction
A ¼" coat finishing cement, wire mesh, ⅛" (dry) asphalt emulsion.
Black
+ Painting
A ¼" coat finishing cement, glass cloth, 2 sprayed coats asphalt cut-back mastic.
Black
+ Painting
Scratch and finish coat insulating cement over wire mesh; 2 coats asphalt emulsion over wire mesh.
Black
+ Painting
Scratch and finish coat insulating cement over wire mesh; vinyl emulsion, adhesive and sealer coat over 8 oz. canvas.
Off-white
+ Painting
Wet Construction



Sketch shows how preformed jacketing snaps back over piping, providing quick installation combined with tight fit. This is also demonstrated in photo titled "Teamwork."

Based on maximum economy and performance, the general recommendation is the use of Kaiser Aluminum alloy 5005 and Kaiser Aluminum industrial roofing and siding.

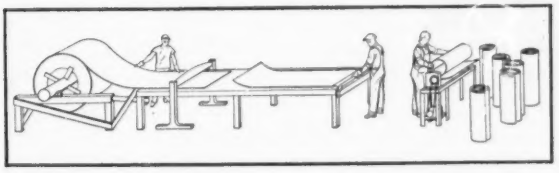
The reasons for this recommendation, and the exceptions to it, are as follows:

(a) Alloys in the 5000 series (which contain magnesium as the principal alloying element) and the clad alloys, such as AlClad 3004 (from which Kaiser Aluminum industrial roofing and siding sheet is made), offer superior corrosion resistance—especially in marine atmospheres.

(b) Alloy 5005 and the industrial roofing and siding alloy provide top performance at lowest cost for most jobs. Alloy 5050 shows an advantage from the standpoint of strength over 5005, and in many instances its slightly increased cost (a fraction of a cent per square foot) is warranted. Where exceptional strength is required, alloy 5052 should be used.

(c) Closely allied with alloy selection is a consideration of the section modulus of jacketing for large diameter vertical vessels. Kaiser Aluminum industrial roofing and siding sheet is superior in section modulus. On certain vertical vessels, usually those in the range of 3′ to 12′ in diameter, some designers prefer the close-up appearance of smaller corrugations. When this is preferred, most of the common alloys and the standard corrugated roofing alloy are satisfactory. Sheets should be 0.024″ thick, embossed, corrugated to 1¼″ x ¼″, and supplied in finished widths of 26″.

A metal thickness of 0.024″ is recommended in most cases. Corrugated aluminum 0.024″ thick can be banded at less material and labor cost than the thinner 0.019″ material fastened with screws. For insulated pipes with an O.D. of 12.75″ and less, 0.020″ thick aluminum sheet is recommended.



These illustrations show method used to fabricate snap jackets:

1. Using aluminum of proper alloy and temper . . .
2. Cutting it to proper dimensions for easy, economical installation . . .
3. Properly stiffening the overlapping edge by a simple angular crimp . . .
4. Forming it through a roller for proper circumference . . .
5. Snapping it around insulated pipe (below).

Teamwork—with one man to snap jackets in place and another to band them, two men can cover 700 feet of 10-inch diameter tubing in one day!

The best temper for pipe jacketing is ¾ hard, designed as H-16 or H-36. For fitting jackets requiring numerous lock seams, ½ hard temper, H-14 or H-34, is recommended.

Pipe Jackets

Snap jackets are a quick, easy and economical method of enclosing insulated pipe. The simple process shown above produces a most effective jacket for pipe insulation. (Kaiser Aluminum's booklet, *"Insulation Jacketing Materials and Methods,"* explains and describes the process in full detail.)

The alloy recommended is 5005-H16, in coiled sheet form with plain finish. Embossed finishes are also available. Other alloys may be used, but it is desirable to use one alloy throughout. Width of coiled sheet should be 36″. Recommended thicknesses of sheets are 0.020″ for insulation O.D. of 12.75″ and under, and 0.024″ for insulation O.D. of 14″ and larger.

Vessel Jackets

Insulated vessels 36″ O.D. and less—horizontal or vertical—should be jacketed with 0.024″ thick by 36″ wide 5005-H16 alloy sheet, plain finish preferred.

For insulated vessels larger than 36″ O.D., horizontal mounting, use the same coiled sheet as above; for vertical mounting, use Kaiser Aluminum industrial roofing and siding, 0.024″ thick, embossed finished, ⅞″ deep corrugations with 2.67″ pitch.

Jackets for Large, Flat Surfaces

For breechings and ducts, indoors and out, Kaiser Aluminum industrial roofing and siding, 0.024″ and 0.032″ thick and having ⅞″ deep by 2.67″ pitch corrugations are most economical. Flat sheet, fluted sheet, and flat sheets stiffened with roll-formed standing seams offer other possibilities.

For insulated boiler walls, jackets may be made of aluminum sheets of several types. Thickness, size and fastening method will vary with specific boiler designs.

Fasteners

For pipes and vessels with insulation O.D. 36″ or smaller, bands may be slit from the same aluminum sheet used for pipe jackets, or they may be purchased as standard stock items. For pipe insulation O.D. 12.75″ and smaller, bands should be ½″ wide by 0.020″ thick, equal to A. J. Gerrard #305-AL; seals should be equal to A. J. Gerrard #202-AL. For pipe or vessels with insulation O.D. 14″ to 36″, bands should be ¾″ wide by 0.020″ thick, equal to A. J. Gerrard #311-AL; seals should be equal to A. J. Gerrard #204-AL. For vessels with insulation O.D. 36″ and larger, ¾″ wide by 0.020″ thick #18-8 stainless steel expansion bands should be used. Banding should be equal to A. J. Gerrard Expand-R-Strap, #E311 ½ S-4; seals should be #18-8 stainless steel, equal to A. J. Gerrard #204-SS.

When required for pipe and fitting jackets, #7 by ½″ aluminum pan head self-tapping screws, Type A, are suggested. Side laps and flashing with corrugated vessel jackets should be fastened with #7 x ¾″ aluminum pan head screws, Type A. Aluminum screws should be made from either 6061-T6 alloy or anodized 2024. For fastening aluminum jackets to steel structural members, use #14 hex head screws, Type B, made from stainless steel #18-8 alloy; #410 is acceptable.

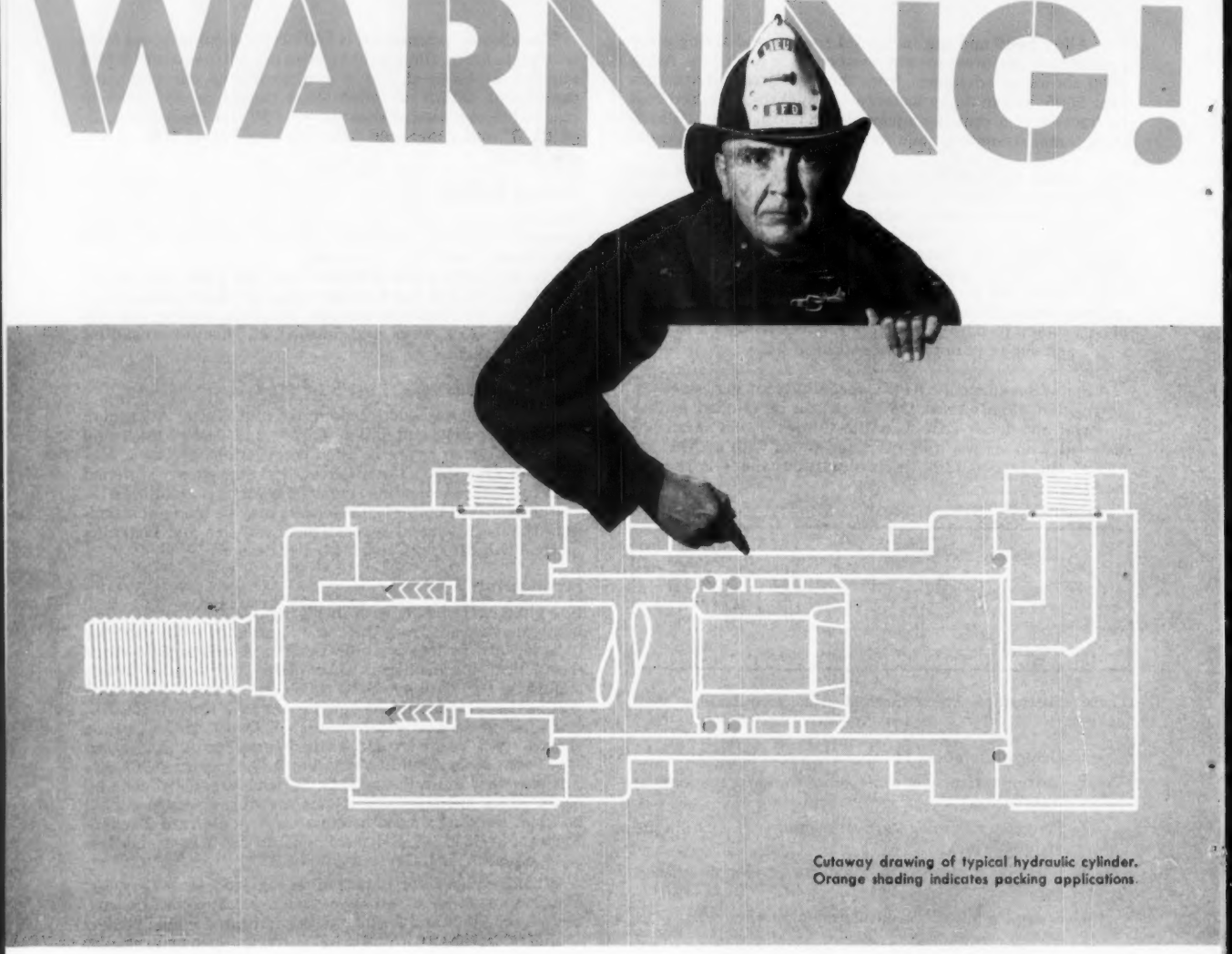
Composite studs made from #18-8 stainless steel and aluminum (equal to Nelson Rivweld Studs or to Nelson Set Lock Studs supplied with aluminum washers) may be used to fasten corrugated aluminum jackets to angles. On siding, fasten studs on low part of corrugation. On roofing, fasten studs on crown of corrugation.

Aluminum Jacketing Booklet Available

Kaiser Aluminum's new booklet, *"Insulation Jacketing Materials and Methods,"* gives you complete details on the subjects outlined above. It also presents illustrated step by step application methods plus material and accessories charts to help you take advantage of recent advances in aluminum sheet jacketing. Forty fully illustrated pages in all! To get your free copy, write to: *Kaiser Aluminum & Chemical Sales, Inc., Process Industries Department, 919 N. Michigan Ave., Chicago 11, Illinois.*

KAISER Aluminum

WARNING!



Cutaway drawing of typical hydraulic cylinder. Orange shading indicates packing applications.

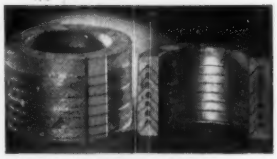
WHEN YOU CHANGE TO A FIRE-RESISTANT HYDRAULIC FLUID, CHANGE PACKINGS, TOO!

Here's why: Many fire-resistant fluids are highly destructive to the common rubbers used for packing mineral base oils.

The Garlock "ORANGE LINE" of packings has been developed specifically, and ONLY, for packing *phosphate ester* type fire-resistant fluids in dynamic applications.

The ORANGE stripe across the packings quickly identifies them as suitable for use against fire-resistant fluids. Butyl Rubber is the base material used in these packings and is *not* compatible with mineral base oils. Therefore the "ORANGE LINE" packings should only be used with the phosphate ester type fire-resistant hydraulic fluids.

*Registered Trademark



Garlock CHEVRON Packing set. Orange stripe quickly identifies packing as suitable for use against fire-resistant fluids.

The Garlock "ORANGE LINE" for fire-resistant hydraulic fluids is available in CHEVRON* Packings, KLOZURE* Oil Seals, Split KLOZURES, U cups, flanges, O-Rings, and other forms of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals to meet *all* your needs. It's the only complete line . . . it's another reason why you get unbiased recommendations from your Garlock representative. Call him today or write for further information on recommended packings for use against fire-resistant hydraulic fluids.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For prompt service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada

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Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

LOUIS N ROWLEY, EDITOR • DECEMBER 1957 • ESTABLISHED 1882 Power

Wider horizons for engineers

SEVERAL TIMES on this page, I've talked about the need for power-service engineers to take a broader view of their responsibilities. In my book technical skill is no longer enough. Today's conditions demand that we play an increasingly important management role. If we are to realize our full potential, we must accept this and prepare ourselves accordingly.

A forward-looking group of power-service men has done just this. I refer to the Institute of Power Engineers of Canada and to the Engineering-Management Seminar that was an outstanding feature of their recent annual meeting. There, more than 100 members of the Institute invested three days of their time, and a substantial fee, to explore the engineer's management problems and, with the guidance of specialists from the Research Institute of America, to discover more effective ways of solving them.

This program is a timely recognition of the fact that power-service operations in many plants are now big business. The top power-service man is thus responsible for a large staff, with all the personnel problems involved, and for major expenses and capital investments, with all the cost-control and budgetary problems involved. Thus just the job of running his own department requires that the power-service engineer be a skilled administrator as well as a competent technical man.

But this is only a beginning. While running the power services efficiently is always the primary responsibility, more and more the engineer in charge must look beyond the narrow confines of his own department and view his operations as they influence all phases of production.

In addition to meeting the immediate power-service needs of production departments, he must be constantly alert to opportunities for boosting output and cutting production costs through power-service improvements. If closer voltage regulation would increase production reliability and precision he must take the initiative in "selling" management on the returns from the investment involved. If improved steam trapping would speed heating processes with consequent savings in production man-hours and increased machinery utilization, he cannot rest content with barely adequate traps, he must make the case for higher-capacity units and make it on the basis of production gains.

These are but a few of the many broad-gage questions to which the power-service engineer must increasingly address himself if he is to realize his full value to the overall production operation. Only by so enlarging his horizons can the power-service engineer make his maximum contribution to the progress and profitability of his company. And only as he does so will he be recognized for what he is—a key member of the management team.

FOR VOLTAGES UP TO 600...

There's a *Safe and Dependable* BUSS Fuse or FUSETRON Fuse to fit the needs of every user

If you want Plug Fuses . . .

Use BUSS Clear Window Plug Fuses

Their one-piece body and "safety" design guarantees protection.

They are most convenient to use too, because real big windows and white backgrounds permits entire fuse strip to be seen. Even in poor light a blown BUSS fuse is easy to find.

If you want to make safe protection REMAIN SAFE as well as REDUCE blowing fuses . . .

Use BUSS Fustats (have Type S base)

FUSTATS like Fusetron Fuses have a dual-element and therefore, stop needless blowing — and they do more.

They have a type S base that prevents anyone from replacing them with a penny or substitute — or using a size too large to protect.

FUSTATS fit standard plug fuse holders by means of an inexpensive adapter that locks in place and needs never to be replaced.

If you want to reduce blowing of Plug Fuses . . .

Use FUSETRON dual-element Plug Fuses

FUSETRON Plug fuses protect like ordinary fuses against short-circuits and overloads — but unlike ordinary fuses they won't blow on motor starting currents or other harmless overloads.

They are the type of fuses recommended in the 1953 National Electrical Code.

To protect motors and apparatus of voltages up to 125 against burnout . . .

Use 0 to 14 amperes BUSS Fustats

A FUSTAT of the proper size installed to handle only the motor current will reduce to a minimum the chance of a motor burnout from an excessive over-current. In like manner it will protect solenoids, coils and transformers against burnout.

FUSTATS have the same degree of Underwriters' approval for both motor-running and short-circuit protection as the most expensive devices made. They give all the protection it is possible to obtain with any device on the market.

FUSES! . . . THE SAFEST AND MOST DEPENDABLE PROTECTION YET DEVISED!

A fuse has just one vital part — a thin narrow strip of fuse metal. When the heat of a short-circuit is applied, the fuse link must melt and open the circuit.

The high speed operation of the fuse reduces to a minimum the danger of short-circuit damage to wiring and equipment.

Fuses offer dependable protection over the years.

The fuse link is sealed in. Dust can't get at it. Corrosion or oxidation can't increase its capacity or lengthen its blowing time.

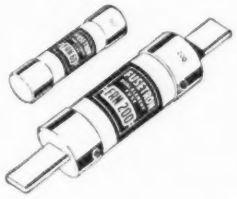
There are no hinges, pivots or contacts to stick or get out of order.

Millions of fuses have been in operation 30 years or more, because there has been no trouble on the

Play Safe! Install BUSS Fuses or

If you want fuses that — abolish all needless blows, stop overheating in panels and switches, protect motors against burnouts . . .

Use FUSETRON dual-element Fuses



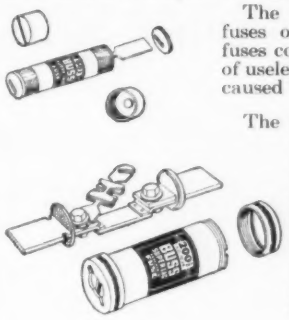
With rare exceptions, ordinary fuses or circuit breakers do not protect except against short-circuit but FUSETRON fuses provide TEN POINT protection.

1. Protect against short-circuits.
2. Protect against needless blows caused by harmless overloads.
3. Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect motors against burnout from overloading.
6. Protect motors against burnout due to single phasing.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Make protection of small motors simple and inexpensive.
9. Protect against waste of space and money — permit use of proper size switches and panels.
10. Protect coils, transformers and solenoids against burnout.

FUSETRON duel-element FUSES save you time and money because they are made to PROTECT — not to blow.

If you want Renewable Fuses . . .

Use BUSS Super-Lag Renewable Fuses



The big advantage of these fuses over all other renewable fuses comes from the prevention of useless interruptions of service caused by needless blows.

The reason for this performance is found in the design of the fuse-case which assures good contact on the fuse link, even if the fuse is renewed by an inexperienced person — and by the time-lag built into the link that prevents the fuse from opening on motor starting currents or other harmless overloads.

If you want SAFE protection on loads above 600 and up to 5000 amps . . .

Use BUSS Hi-Cap Fuses

On voltages up to 600, high speed operation on heavy shorts limits current to safe values. This minimizes damage to equipment and cuts down dangerous stresses on transformers.

For Short-Circuit Protection or when fast opening is desired . . .

Use BUSS Limitron Fuses

The extremely fast opening characteristics of these fuses prevent heavy short-circuit currents from building up under fault conditions.

If you want Non-Renewable Fuses . . .

Use BUSS One-Time Fuses

They save you time and trouble because they get the same engineering care in manufacture as do all products carrying the BUSS Trademark.

Every BUSS One-Time fuse can be depended upon to operate as intended under all service conditions.

For protection of TV, Radio, Instruments, Radar, Avionics and Electronic Equipment . . .

Use BUSS and FUSETRON Small Dimension Fuses

A complete line is available. Made in Dual-element (slow-blowing), Renewable and One-Time types in sizes from 1/500 ampere up.

And there is a companion line of BUSS Fuse Clips, Fuse Blocks and Fuse Holders to take them.

circuits they are protecting and therefore no occasion to open.

Yet, after years of inactivity, you can be sure the fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

NO RECALIBRATION COSTS

When Fusetron fuses do blow, there is no recalibration needed. As quickly as the fault in the circuit is corrected, you slip in a new fuse that has been CALIBRATED AT THE FACTORY BY ENGINEERS — a fuse that is as safe and dependable as the one that blew.

Fusetron Fuses Now! THROUGHOUT THE ENTIRE ELECTRICAL SYSTEM

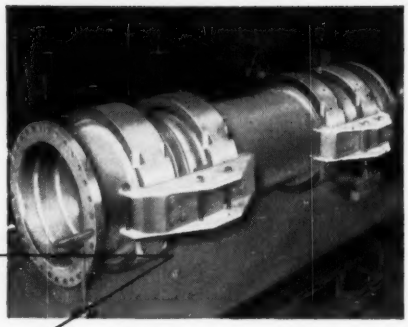
FOR MORE INFORMATION ON BUSS AND FUSETRON FUSES WRITE TO BUSSMANN MFG. DIVISION McGRAW-EDISON CO. ST. LOUIS 7, MO.

FUSETRON

TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

BUSS

ALL IN A DAY'S WORK at *Pittsburgh Piping*



Every Pittsburgh Piping job is different, but all are alike in one respect . . . to control the flow and harness the energy of high temperature steam, gases, or liquids at high pressures. It's all in a day's work at Pittsburgh Piping to fabricate piping for a central station, an atomic energy installation, or for industrial and processing operations. Our service includes every phase from blueprint through erection: engineering, metallurgical control, pipe bending, machining, welding, heat treating, inspection, and testing. Use these facilities on your high temperature, high pressure piping jobs.

this BIG 10-TON EXPANSION JOINT

36" carbon steel joint, weighing ten tons, for cross-over piping in central station.

and this small PRESSURE RISER CONDENSER

Pressure riser condenser, fabricated of Stainless Steel Type 347; 2 feet high; wall thickness equivalent to 4" Schedule 1605. Stainless steel pressure vessel, for atomic energy application, appears in background.

Promoting Progress ***IN POWER AND PROCESS PIPING***

Pittsburgh Piping **AND EQUIPMENT COMPANY**
158 49th Street—Pittsburgh, Pa.

Canada: CANADIAN PITTSBURGH PIPING, LTD., 835 BEACH ROAD—HAMILTON, ONTARIO

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Cleveland	Public Square Building	Syracuse	113 So. Salina Street
Toronto	68 Yonge Street		

Power presents its 1957

modern plant survey

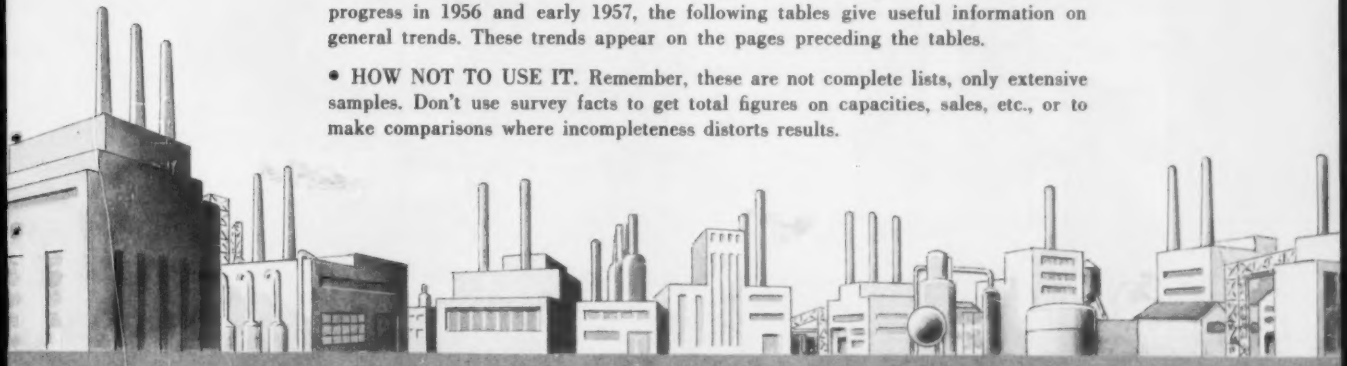
These pages bring you the most data available anywhere on design features of steam and hydro units planned, under construction and starting operation. Because of the way we must compile facts, the survey does not include all current programs, nor does it consist only of current construction. Let us tell you how the job's done and point out listing limitations—so you can use the survey effectively.

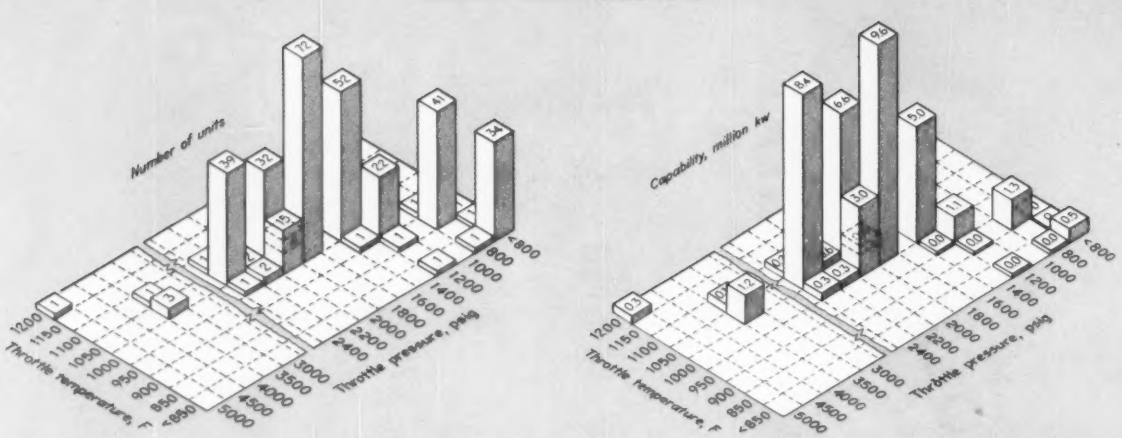
• HOW WE DO THE JOB. As a continuing service, POWER'S editors assemble news of installations planned or ordered. We send questionnaires to individual companies asking for project details. The replies go into the tables, compiled at approximately yearly intervals—last survey appeared in the Mid-September 1956 issue.

• ITS LIMITATIONS. In the nature of things, you can see these tabulations can't be complete. Nor can published lists correspond exactly in point of time with actual installations or announcements of them. Data may appear in the tables well before construction starts, or if engineering is delayed, may not appear until long after a project is announced. Revised listings duplicated from previous surveys are so marked.

• HOW TO USE SURVEY. Being representative of design and construction in progress in 1956 and early 1957, the following tables give useful information on general trends. These trends appear on the pages preceding the tables.

• HOW NOT TO USE IT. Remember, these are not complete lists, only extensive samples. Don't use survey facts to get total figures on capacities, sales, etc., or to make comparisons where incompleteness distorts results.

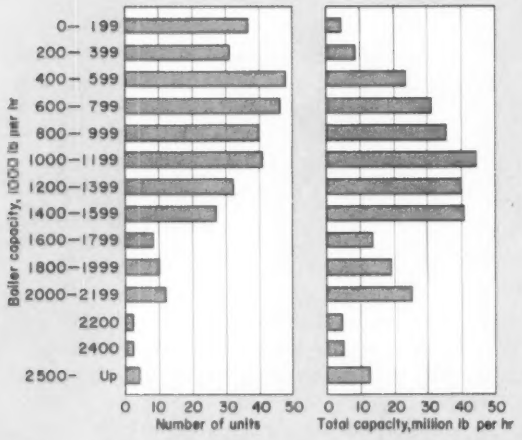




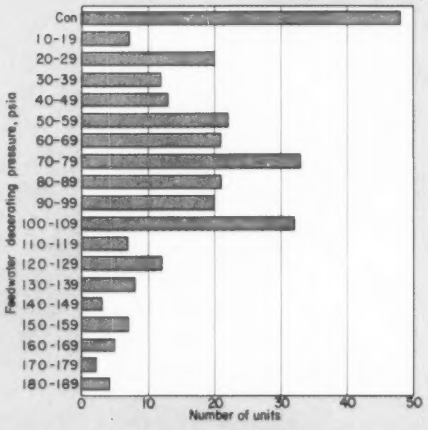
THROTTLE STEAM CONDITIONS at higher levels are being used by an increasing proportion of the new and planned units

MORE THAN HALF of new turbine capability starting in 1957 and later will use steam at 2000 psig, 1000 F and higher

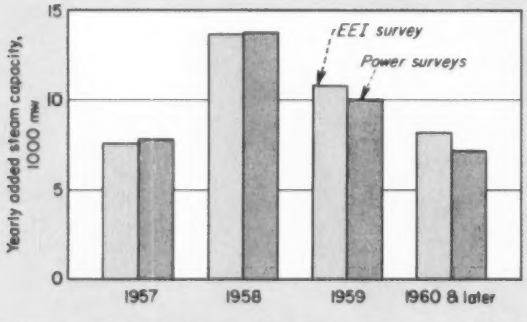
Trends in CENTRAL STATIONS



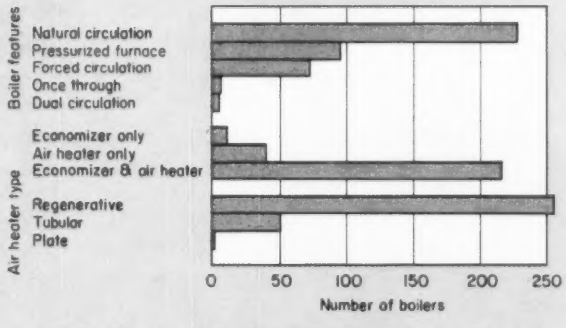
STEAM-GENERATOR CAPACITIES keep pace with demand for larger power packages, largest generates 3,850,000 lb per hr



FEEDWATER DEAERATING pressures run at higher levels for new units, less than 20% use condenser deaeration only

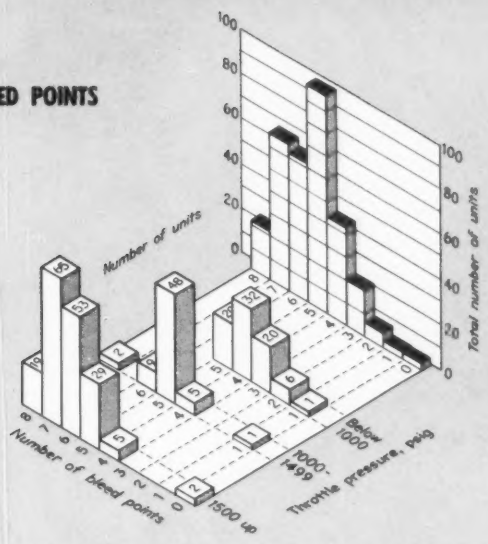


POWER SURVEY in this and previous reports covers 95% of 40,200-mw steam capability scheduled to start '57 and later



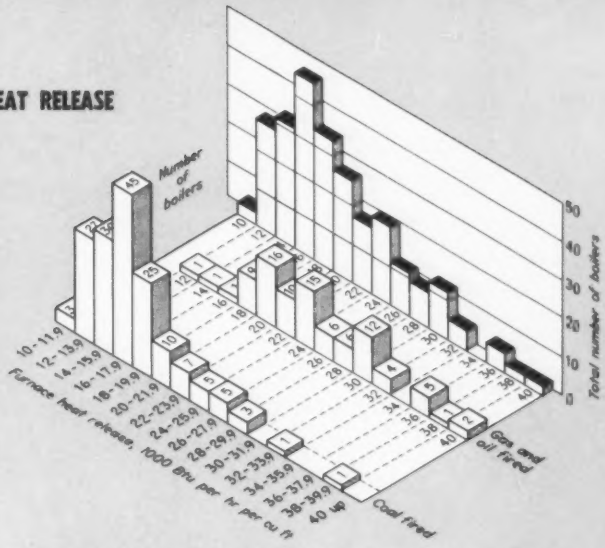
STEAM-GENERATOR FEATURES show growing use of all heat-recovery units, increasing acceptance of pressurized furnaces

BLEED POINTS

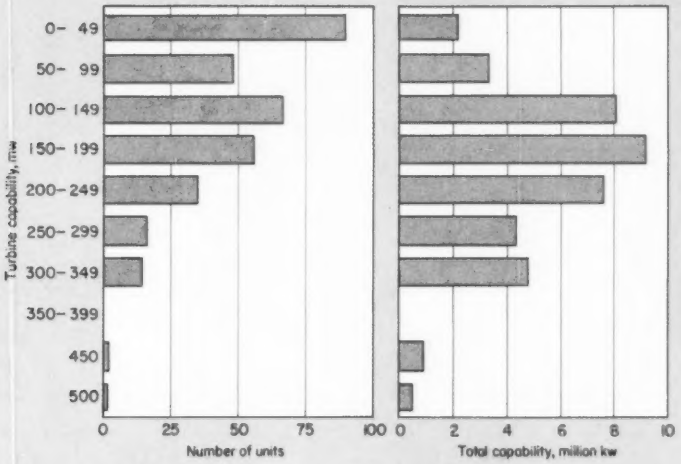


FIVE BLEED POINTS still predominant for all turbines but 7 points finds most frequent use in high-pressure units

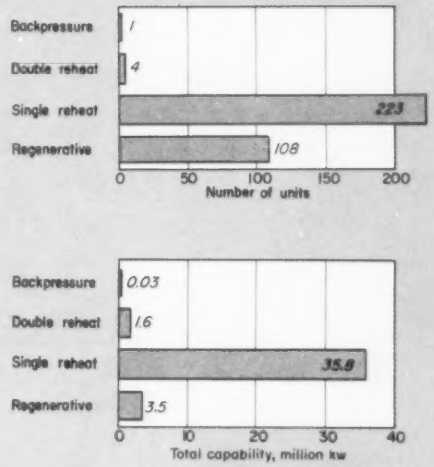
HEAT RELEASE



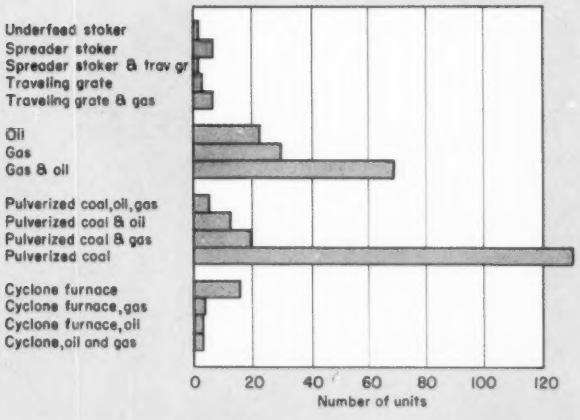
FURNACE HEAT RELEASE rate continues drifting towards lower values as coal-fired boilers increase proportionately



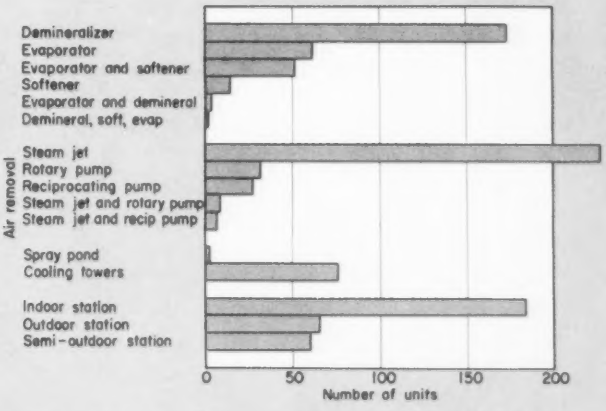
TURBINE CAPABILITIES respond to rising demands for power with more larger units, average size of future units is 126 mw; largest is 500 mw — sets new record



REHEAT TURBINES are preferred for new units, they have average size of 165 mw



FIRING EQUIPMENT shows slight increase in proportion of coal-fired furnaces with drop off for oil and natural gas



STATION FEATURES show proportion of indoor plants holds about the same as in earlier modern power plant surveys

1957 Design Survey of Typical New

Compiled by Althea Thornton, Assistant Editor

Company	Location	Plant name	Consulting engineers	Unit No., new units	First operation-new units	Throttle pressure, psig	Steam temp, F: Throttle	Steam temp, F: Reheat	BOILERS: Number	BOILERS: Capacity, each, 1000 lb per hr	BOILERS: Manufacturer	BOILERS: Surface, 1000 sq ft: Boiler & WW	BOILERS: Surface, 1000 sq ft: Superheater	BOILERS: Surface, 1000 sq ft: Reheater
Philadelphia Electric Co	Eddystone, Pa.	Eddystone		1[1]	12-58	5000[a]	1200	1050[a]	1	2000	CE	77	38	103
				2[1]	1-60	3500	1050	1050[a]	1	2178	CE	68	25	102.5
Indiana-Michigan Electric Co	Fairbanks, Ind.	Breed	American Gas & Electric Svc Corp	1	7-59	3500[a]	1050	1050[a]	1[e]	2923	BW	–	–	–
Ohio Power Co	New Haven, W.Va.	Philip Sporn	American Gas & Electric Svc Corp	5	12-59	3500[a]	1050	1050[a]	1[e]	2923	BW	–	–	–
	Cresap, W. Va.	Kammer[12]	American Gas & Electric Svc Corp	3	1958	2015	1050	1050	1	1523	BW	11.5	–	–
Consumers Power Co	Essexville, Mich.	Dan E Karn	Commonwealth Associates Inc	1	7-59	2450	1050	1050	1	1750	CE	27.7	114.7	37.8
				2	6-60	2450	1050	1000	1	1750	BW	–	–	–
Central Hudson Gas & Electric Corp	Roseton, N.Y.	Danskammer Pt	Burns & Roe Inc	3	1959	2400	1050	1000	1	950	CE	18.0	84	19.0
Cincinnati Gas & Electric Co	Columbia Park, Ohio	Miami Fort	Sargent & Lundy	6	9-59	2400	1050	1000	1	1000	CE	19.6	104.6	16.4
Cleveland Electric Illuminating Co	Ashtabula, Ohio	Ashtabula		5	12-58	2400	1050	1050	1	1500	CE	44.6	159.2	33.3
Detroit Edison Co	East China Twp, Mich.	St. Clair		5	4-59	2400	1050	1000	1	2100	BW	15.5	–	–
				6	10-60	2400	1050	1000	1	2100	CE	38.3	–	–
	Detroit, Mich.	Beacon St[13]		3	10-59	850	700	–	1	500	CE	5.1	4.2	N
Duke Power Co	Belmont, N.C.	Allen		3	9-59	2400	1050	1000	1	1800	CE	35.9	170	31.5
				4	7-60	2400	1050	1000	1	1800	CE	35.9	170	31.5
Niagara Mohawk Power Corp	Dunkirk, N.Y.	Dunkirk		3	1959	2400	1050	1000	1	1470	CE	18.4	116.3	24.7
				4	1959	2400	1050	1000	1	1470	CE	18.4	116.3	24.7
	Buffalo, N.Y.	Huntley		68	1958	2400	1050	1000	1	1470	CE	18.4	116.3	24.7
Ohio Edison Co	Stratton, Ohio	Stratton	Commonwealth Associates Inc	3	9-60	2400	1050	1000	1	1250	FW	27.4	37.6	67.6
				4	9-61	2400	1050	1000	1	1250	FW	27.4	37.6	67.6
Pacific Gas & Electric Co	Pittsburg, Calif.	Pittsburg		5	1-60	2400	1050	1000	1[e]	2160	BW	–	–	–
				6	1-61	2400	1050	1000	1[e]	2160	BW	–	–	–
Pennsylvania Electric Co	Shawville, Pa.	Shawville	Gilbert Associates Inc	3	5-59	2400	1050	1000	1	1200	CE	21.3	118.4	17.9
				4	12-59	2400	1050	1000	1	1200	CE	21.3	118.4	17.9
Pennsylvania Power & Light Co	York Haven, Pa.	Brunner Island	Ebasco Services Inc	1	8-60	2400	1000	1000	1[e]	2100	CE	34.2	179	50.0
Potomac Electric Power Co	Dickerson, Md.	Dickerson	Stone & Webster Engrg Corp	1	6-59	2400	1050	1000	1	1300	CE	25.4	104.7	24.3
South Carolina Electric & Gas Co	Irmo, S.C.	Silas C McMeekin	Gilbert Associates Inc	1[1]	5-58	2400	1050	1000	1	910	CE	19.1	74.2	17.2
				2[1]	10-58	2400	1050	1000	1	910	CE	19.1	74.2	17.2
Southern California Edison Co	Huntington Beach, Calif.	Huntington Beach	Bechtel Corp	1	6-58	2400	1050	1000	1[e]	1560	BW	12.8	114.8	30.7
				2	12-58	2400	1050	1000	1[e]	1560	BW	12.8	114.8	30.7
	Near Oxnard, Calif.	Mandalay	Bechtel Corp	1	4-59	2400	1050	1000	1[e]	1560	BW	12.8	114.8	30.7
				2	9-59	2400	1050	1000	1[e]	1560	BW	12.8	114.8	30.7
Wisconsin Electric Power Co	Oak Creek, Wisconsin	Oak Creek		5	1959	2400	1050	1000	1	1780	FW	76.4	40.7	8.0
Public Service Electric & Gas Co	Ridgefield, N.J.	Bergen		1	1958	2350	1100	1050	1[e]	1900	FW	53.5	88.7	82.3
				2	1958	2350	1100	1050	1[e]	1900	FW	53.5	88.7	82.3
Public Service Co of Oklahoma	Tulsa, Oklahoma	Tulsa	Black & Veatch	2[1e]	9-56	2070	1000	1000	1[e]	1150	BW	11.6	–	–
				4[1e]	3-58	2070	1000	1000	1[e]	1150	BW	11.6	–	–
			Sargent & Lundy	3	3-57	1575	1000	–	1[e]	885	BW	4.5	–	–
Alabama Power Co	Bucks, Ala.	Barry	Southern Services Inc	3	5-59	2000	1000	1000	1	1700	CE	33.6	104.7	30.2
Appalachian Electric Power Co	Carbo, W. Va.	Clinch River	American Gas & Electric Svc Corp	1	4-58	2000	1050	1050	1[e]	1523	BW	–	–	–
				2	7-58	2000	1050	1050	1[e]	1523	BW	–	–	–
Central Illinois Public Service Co	Meredosia, Ill.	Meredosia	Sargent & Lundy	3	6-60	2000	1050	1000	1	1350	CE	39.4	77.8	26.3
Commonwealth Edison Co	Chicago, Ill.	Crawford	Sargent & Lundy	7	5-58	2000	1050	1050	1	1450	CE	25.5	149.8	29.2
	Waukegan, Ill.	Waukegan	Sargent & Lundy	7	6-58	2000	1050	1000	1	2050	CE	36.6	210.3	40.5
	Chicago, Ill.	Fisk	Bechtel Corp	19	12-58	2000	1050	1000	1	2200	CE	42.0	210.3	40.5
	Joliet, Ill.	Joliet	Sargent & Lundy	6	5-59	2000	1050	1000	1	2200	BW	63.9	162.4	107.8
	Chicago, Ill.	Northwest	Sargent & Lundy	4	12-57	230	560	–	–	–	–	–	–	–
Connecticut Light & Power Co	Norwalk, Conn.	Norwalk Harbor	United Engineers & Constructors	1	10-59	2000	1000	1000	1	1150	CE	18.4	97.6	20.2
Consolidated Edison Co. of N.Y., Inc.	Queens, New York, N.Y.	Astoria		4	1961	2000	1050	1000	1	2500	CE	50.0	160	38.0
Houston Lighting & Power Co	Strang, Texas	Sam Bertron	Ebasco Services Inc	3	2-59	2000	1000	1000	1[e]	1550	CE	25.3	97.7	30.0
				4	1-60	2000	1000	1000	1[e]	1550	CE	25.3	97.7	30.0
	North Houston, Texas	North Houston	Ebasco Services Inc	2	1-60	2000	1000	1000	1[e]	1550	CE	25.3	97.7	30.0
				1	4-58	1250	950	–	1[e]	650	RS	24.8	25.9	N
	Fort Bend, Texas	Smithers Lake	Ebasco Services Inc	3	1961	2000	1000	1000	1[e]	1950	FW	14.6	30.8	58.8
Illinois Power Co	N.E. of Hennepin, Ill.	Hennepin	Sargent & Lundy	2	5-59	2000	1050	1050	1	1350	CE	39.4	79.7	26.8
Mississippi Power & Light Co	Jackson, Miss.	Rex Brown	Ebasco Services Inc	4	3-59	2000	1000	1000	1[e]	1560	BW	–	–	–
Oklahoma Gas & Electric Co	nr Oklahoma City, Okla.	Mustang	Sargent & Lundy	4	5-59	2000	1000	1000	1	1560	BW	34.3	90.8	73.2
San Diego Gas & Electric Co	Chula Vista, Calif.	South Bay	Pioneer Service & Engrg Co	1	7-60	2000	1000	1000	1[e]	980	BW	–	–	–
	Carlsbad	Encina	Pioneer Service & Engrg Co	3	7-58	1450	1000	1000	1	800	BW	–	–	–
Southern Electric Generating Co	Wilsonville, Ala.	Segco No. 1	Southern Services Inc	1	4-60	2000	1000	1000	1	1700	BW	25.7	–	–
				2	7-60	2000	1000	1000	1	1700	BW	25.7	–	–
Texas Electric Service Co	Graham, Texas	Graham	Ebasco Services Inc	1	2-60	2000	1000	1000	1[e]	1550	FW	3.0	21.4	46.2
	Colorado City, Texas	Morgan Creek	Ebasco Services Inc	5	5-59	1800	1000	1000	1[e]	1300	RS	23.2	75.2	49.9
Toledo Edison Co	Lake Erie, Maumee Bay	Bay Shore	G T Saathoff	2	1-58	2000	1050	1000	1	950	BW	35.2	72.8	43.7
Public Service Company of Oklahoma	Oologah, Okla.	Oologah	Black & Veatch	1	3-61	1980	1000	1000	1[e]	1150	BW	11.6	50.0	11.2
Arizona Public Service Co	nr Tempe, Ariz.	Ocotillo	Ebasco Services Inc	1	4-60	1800	1000	1000	1[e]	800	CE	18.3	–	–
				2	2-60	1800	1000	1000	1[e]	800	CE	18.3	–	–
	Yuma, Ariz.	Yuma-Axis[26]	Bechtel Corp	1	3-61	1800	1000	1000	1[e]	575	CE	14.1	–	–

A – Anthracite
AC – Allis-Chalmers Mfg Co
Ad – Admiralty
AdD – Admiralty D
Adi – Admiralty, Inhibited
Al – Aluminum
AlB – Aluminum Bronze
AlBr – Aluminum Brass
AlBri – Inhibited Aluminum Brass
AnAd – Antimonial Admiralty
AsAd – Arsenical Admiralty
AsAdB – Arsenical Admiralty Bronze
AsAdI – Inhibited Arsenical Admiralty
AsCu – Arsenical Copper
B – Variable pitch blade
BB – Brown Boveri Corp
Br – Brass
BW – Babcock & Wilcox Co
BWG – Babcock-Wilcox & Goldie-McCulloch Ltd
C – Coal, bituminous
CE – Combustion Engineering Inc
CES – Combustion Engineering-Superheater Ltd
CNi – Cupro nickel
Con – Condenser deaeration
CP – C A Parsons & Co, Ltd
Cy – Cyclone furnace
D – Damper
DB – Dry bottom
Du – Dual turbine and motor drive
EC – Erie City Iron Works
EE – English Electric Co Ltd
EL – Elliott Co
FW – Foster Wheeler Corp
G – Natural Gas
GE – General Electric Co
Hy – Hydraulic coupling
L – Lignite
M – Motor drive
Ma – Magnetic coupling
Mp – Two motors per fan
MV – Metropolitan-Vickers Electrical Co Ltd
N – None
O – Oil
P – Pulverized
PAd – Phosphorized Admiralty

Steam Central-Station Installations

Furnace volume, 1000 cu ft	Heat release, 1000 Btu per cu ft per hr	Furnace bottom	Economizer surface per boiler, 1000 sq ft	Air-heater surface per boiler, 1000 sq ft	Air-heater type	F-D FANS: Drive	F-D FANS: Air-flow control	I-D FANS: Drive	I-D FANS: Gas-flow control	Firing	FUELS: Type	FUELS: Heating value 1000 Btu per lb	FUELS: Ash-softening temperature, F	FEED PUMPS: Drive	FEED PUMPS: Flow control	TURBINES: Number	TURBINES: Capability, each 1000 kw	TURBINES: Manufacturer	TURBINES: Backpressure, psia	TURBINES: No. bleed points	Full-load steam-line pressure, psia	CONDENSERS: Surface, 1000 sq ft	CONDENSERS: No. water passes	CONDENSERS: Tube material	Total boiler capacity (incl new units), 1000 lb per hr	Total generator capability (incl new units), 1000 kw
221	12.3	DB	117.4	804	Re	M	V	M	D	P	C	13.5	2100	4M, 2T	S	1[4]	325	WE	0.5	8	54.3	150	1	Adl	4178	650
221	12.8	DB	90.0	950	Re	M	V	M	D	P	C	13.5	2100	4M, 2T	S	1[11]	325	GE	0.5	7	76.0	150	1	Adl		
–	–	ST[6]	–	–	Re	M	V	N	N	Cy	C	11.3	2175	1M[10], 1T	S	1[11]	450	GE	0.75	8	48	198	1	AsCu	2923	450
–	–	DB[6]	–	–	Re	M	V	N	N	P	C	11.0	2300	1M[10], 1T	S	1[11]	450	GE	0.75	8	48	198	1	AsCu	6643	1050
–	–	ST[6]	–	–	Re	M	V	N	N	Cy	C	10.5	2000	1T	S	1[4]	225	GE	0.75	–	50	100	1	Ad	4569	675
153	–	DB	58.8	378.4	Re	M	V	M	D	P	C	10.7	2100	4M	R	1[9,11]	250	WE	0.5	8	Con	115	1	Adl	3500	500
–	–	DB	–	–	Re	M	V	M	D	P	C	10.7	2100	4M	R	–	–	–	–	–	–	–	–	–		
66.0	18.0	DB	60.1	112.7	Re	M	D	M	V	P	C	13.2	2000	2M	R	1	138	GE	0.5	7	90.6	95	–	Ad	1950	278
105	13.0	DB	27.8	272	Re	M	V	M	D,Ma	P	C	11.5	2350	3M	Hy	1	172	GE	0.75	7	120	80	2	AsAd	4390	525
124	16.9	DB	46.2	480.9	Re	M	V	M	V	P	C	11.4	2250	3M	R	1	250	GE	0.5	7	55.3	110	1	Ad	4300	490
112	24.3	ST	63.2	649	Re	M	V	M	V	Cy	C	11.7	2200	3M[10]	Hy	1[4]	325	GE	0.5	7	Con	170	1	Al	8480	1346
204	13.5	DB	123.3	487	Re	M	V	M	V	P	C	11.7	2200	3M[10]	Hy	1[4]	325	WE	0.5	7	Con	170	1	–		
30.5	22.8	–	40.0	N	N	M	V	M	V	UF(823)	C	13.2	2500	2M[10];1T[10]	S	1	19	–	165	–	20	–	–	–	2380	26.8
165	14.8	DB	37.6	131.5	Re	M	V	M	D	P	C	13.3	2260	2M	Hy	1[4]	290	GE	0.75	7	Con	160	2	Adl	5920	900
165	14.8	DB	37.6	131.5	Re	M	V	M	D	P	C	13.3	2260	2M	Hy	1[4]	290	Ge	0.75	7	Con	160	2	Adl		
104	18.0	DB	38.0	312.6	Re	M	V	M	S	P	C	13.3	2050	1T	S	1[4]	200	GE	0.75	7	40	95	–	Adl	–	600
104	18.0	DB	38.0	312.6	Re	M	V	M	S	P	C	13.3	2050	1T	S	1[4]	200	GE	0.75	7	40	95	–	Adl		
104	18.0	DB	38.0	312.6	Re	M	V	M	S	P	C	13.3	2050	1T	S	1[4]	200	GE	0.75	7	40	95	–	Adl	–	1200
99	17.1	DB[6]	53.6	280.2	Re	M	V	M	V	P	C	11.0	2100	3M	R	1	170	WE	1.75	8	Con	90	2	Adl	5000	680
99	17.1	DB[6]	53.6	280.2	Re	M	V	M	V	P	C	11.0	2100	3M	R	1	170	WE	1.75	8	Con	90	2	Adl		
–	–	–[6]	–	–	Re	M	D,V	N	N	G,O	G,O	1025[7]	–	–[8]	–	1[9,11]	300	WE	0.75	7	Con	130	–	AlBr	8640	1300
–	–	–[6]	–	–	Re	M	V	N	N	G,O	G,O	1025[7]	–	–[8]	–	1[9,11]	300	GE	0.75	7	Con	130	1	AlBr		
96.0	16.6	DB	31.3	305.8	Re	M	V	M	D	P	C	12.7	2100	2M	Hy	1	185	GE	1.75	7	110	110	2	–	4188	646
96.0	16.6	DB	31.3	305.8	Re	M	V	M	D	P	C	12.7	2100	2M	Hy	1	185	GE	1.75	7	110	110	2	–		
203	14.0	DB	52.8	348.8	Re	M	V	M	V	P	C	12.9	2050	3M[16]	R	1[9,11]	330	WE	0.75	7	90	150	2	Ad	2100	330
93.5	17.6	DB	62.6	475	Re	M	D	M	Hy	P	C	13.2	2000	1T[17], 1T	S,Ma	1[4]	175	GE	1.0	7	45	110	2	Ad	1300	175
52.5	22.0	DB	38.1	176.4	Re	M	Hy	M	Hy	P	C	13.5	2500	3M	Ma	1[4]	125	GE	0.5	7	130	70	2	Adl	1820	250
52.5	22.0	DB	38.1	176.4	Re	M	Hy	M	Hy	P	C	13.5	2500	3M	Ma	1[4]	125	GE	0.5	7	130	70	2	Adl		
91.9	21.5	–[6]	12.4	262	Re	M	Hy	N	N	O,G	O,G	17.9	–	2M[10]	Hy	1[4,9]	200	GE	0.75	6	53	110	2	AlBr	3120	400
91.9	21.5	–[6]	12.4	262	Re	M	Hy	N	N	O,G	O,G	17.9	–	2M[10]	Hy	1[4,9]	200	GE	0.75	6	53	110	2	AlBr		
91.9	21.5	–[6]	12.4	305	Re	M	Hy	N	N	O,G	O,G	17.9	–	2M	Hy	1[4,9]	200	GE	0.75	7	53	110	2	AlBr	3120	400
91.9	21.5	–[6]	12.4	305	Re	M	Hy	N	N	O,G	O,G	17.9	–	2M	Hy	1[4,9]	200	GE	0.75	7	53	110	2	AlBr		
172.7	13.1	DB	376	795.3	Re	M	D	M	S	P	C	12.4	–	1M,1T	S,R	1[4]	275	AC	0.25	7	Con	159	1	Al	–	775
173	14.3	ST[6]	86.9	326.6	Re	M	Hy	N	N	P	C	13.0	2100	1M, 1[17]	Hy	1[11]	290	WE	0.75	8	Con	130	1	AlBr	3800	580
173	14.4	ST[6]	86.9	278	Re	M	Hy	N	N	P	C	13.0	2100	1M, 1[17]	Hy	1[11]	290	WE	0.75	8	Con	130	1	AlBr		
51.2	–	–[6]	15.1	205	Tu	M	D	–[6]	–	G,O	G,O	1000[7]	–	3M	–	1[9,9]	175	WE	1.0	5	115	120	2	Adl	4490	500
51.2	–	–[6]	15.1	205	Tu	M	D	–[6]	–	G,O	G,O	1000[7]	–	3M	–	1[9,9]	175	WE	1.0	5	115	120	2	Adl		
40.5	–	–[6]	22.5	188.5	Tu	M	V	–[6]	–	G,O	G,O	1000[7]	–	3M	–	1[9,9]	40.5	WE	285	0	65	–	–	–		
147	15.4	DB	83.5	400	Re	M	Hy	M	Hy	P	C	11.9	2550	3M	Hy	1[11,20]	225	WE	1.0	5	93.6	150	1	Ad	3500	475[20]
–	–	DB[6]	–	–	Re	M	V	N	N	P	C	12.5	2400	1T	S	1[4]	225	GE	0.75	7	103	130	2	AsAd	2860	450
–	–	DB[6]	–	–	Re	M	V	N	N	P	C	12.5	2400	1T	S	1[4]	225	GE	0.75	7	103	130	2	AsAd		
128.5	14.8	DB	74.8	300.8	Re	M	V	M	Hy	–	C	10.4	1960	3M	Hy	1	200	AC	0.75	7	115	125	2	AsCu	2490	325
149	13.0	DB	56.0	375.9	Re	M	D	M	V	P	C	10.0	2000	3M	Hy	1	219.5	GE	0.5	7	51	110	1	PAd	4150	455
252	11.0	DB	76.7	508.8	Re	M	V	M	Hy	P,G	C,G	10.0	2000	4M	Hy	1[4]	325	GE	0.5	7	80	180	1	Al	5893	713
265.5	83.9[14]	DB	76.7	508.8	Re	M	D	M	S,D,Hy	P	C	10.0	2000	3M[10]	S,Hy	1[4]	327.2	AC	0.5	7	125	200	1	PAd	6540	641
273	13.0	ST	69.2	541.6	Re	M	V	M	Hy	Cy	C	10.0	2000	3M	Hy	1[4]	325	GE	0.5	7	74	190	1	Ad	4100	496
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1[21]	35	WE	0.75	2	–	48	2	AsAdB	2500	222
82.4	85.8[14]	DB	20.8	112.5	Re	M	V	M	D	P	C	13.2	2200	2M	Hy	1	150	GE	1.75	6	Con	70	1	AlBr	1150	150
250	13.0	DB[6]	131.0	546.0	Re	M	V	–[6]	–	P	C	13.6	1900	1M[10], 1[17]	Hy	1[4]	340	AC	1.0	7	150	187	1	AlBr	7600	1060
94.8	23.0	–[6]	23.3	344.6	Re	M	V	N	N	G,O[22]	G,O	1018[7]	–	3M	R	1[9]	220	GE	1.72	7	190	110	1	AlBrl	5550	790
94.8	23.0	–[6]	23.3	344.6	Re	M	V	N	N	G,O[22]	G,O	1018[7]	–	3M	R	1[9]	220	GE	1.72	7	190	110	1	AlBrl		
94.8	23.0	–[6]	23.3	344.6	Re	M	V	N	N	G,O[22]	G,O	1018[7]	–	3M	R	1[9]	220	AC	1.72	7	190	130	2	AsAd	2200	286
32.0	26.0	–[6]	N	79.0	Re	M	V	N	N	G[22]	G	1018[7]	–	2M	R	1[9]	66	AC	0.73	5	94	60	2	AsAd		
110.0	25.2	–[6]	73.7	469.2	Re	M	V	M	–	G,O	G,O	1018[7]	–	3M	R	1[9]	275	WE	2.0	7	170	145	1	AsCu	4320	605
128.5	15.1	DB	79.1	300.8	Re	M	V	M	Hy	P	C	10.4	1960	3M	Hy	1[4]	200	GE	1.75	7	65	125	2	Ad	1875	275
–	–	DB[6]	–	–	Re	M	D	–[6]	–	O,G	O,G	1069[7]	–	3M	R	1[9]	243	WE	0.75	7	107	115	2	Ad	–	418
112.8	19.4	DB[6]	16.5	241.6	Re	M	V	–[6]	–	G,O	G,O	1180[7]	–	2M	Hy	1	236	WE	1.0	7	124	110	2	PAd	3385	450
–	–	–[6]	–	–	Re	M	S,D,Hy	–[6]	–	O,G	O,G	17.9	–	2M	Hy	1[9]	130	GE	0.75	7	100	–	2	AlBr	980	130
–	–	–	–	–	Re	M	D,Hy	M	D,Hy	O,G	O,G	18.0	–	2M	Hy	1	106	GE	0.75	5	105	–	–	–	2145	318
139.5	–	DB	28.9	524	Re	M	Hy	M	Hy	P	C	12.0	2550	3M	Hy	1[4,20]	225	GE	1.0	5	86	150	2	Ad	1700	225
139.5	–	DB	28.9	524	Re	M	Hy	M	Hy	P	C	12.0	2550	3M	Hy	1[4,20]	225	GE	1.0	5	86	150	2	Ad	3400	450
90.0	24.4	DB[6]	64.1	296.2	Re	M	Hy	–[6]	–	G,O	G,O	1058[7]	–	2M	Hy	1[9]	220	AC	1.75	7	150	115	1	Ad	1550	220
81.8	20.6	DB[6]	17.4	124.6	Re	M	V	–[6]	–	O,G	O,G	19.0	–	2M	R	1[9]	175	WE	1.75	7	Con	90	1	Ad	2850	310
98.4	12.5	DB	22.3	366.5	Tu	M	V	M	V	P	C	12.4	1900	3M	Hy	1	142	WE	0.5	8	45	85	1	Ad	1900	284
51.3	–	–[6]	15.1	205.0	Tu	M	D	–[6]	–	G,O	G,O	1015[7]	–	3M	R	1[9]	175	WE	1.0	5	85	120	2	Adl	1150	175
53.0	21.8	–[6]	15.3	65.9	Re	M	D,V	–[6]	–	G	G	1097[7]	–	2M	Hy	1[9]	110	WE	1.75	5	87	65	2	–	800	110
53.0	21.8	–[6]	15.3	65.9	Re	M	D,V	–[6]	–	G	G	1097[7]	–	2M	Hy	1[9]	110	WE	1.75	5	87	65	2	–	1600	220
31.5	25.8	–[6]	13.0	109.5	Re	M	V	–[6]	–	G	G	1078[7]	–	2M	Hy	1[9]	80	WE	1.75	5	–	45	2	–	1150	160

Pl – Plate
R – Regulator
Re – Regenerative
RS – Riley Stoker Corp
S – Speed control
SiB – Silicon Bronze
SP – Springfield Boiler Co
SS – Spreader stoker
ST – Slag tap
T – Turbine drive
TG – Traveling grate stoker
Tu – Tubular

UF – Underfeed stoker
UI – Union Iron Works
V – Vane control
WE – Westinghouse Electric Corp
WI – Wickes Boiler Co
(823) – Stoker grate area, sq ft
1 – Revised data, previously listed 9-56
2 – Once-through boiler
3 – Double reheat
4 – Hp 3600 rpm, lp 1800 rpm
5 – Preferred standard
6 – Pressurized furnace

7 – Btu per cu ft
8 – Two, driven by main unit shaft
9 – Outdoor installation
10 – Half capacity
11 – Hp 3600 rpm, lp 3600 rpm
12 – Units 1 and 2 listed under Appalachian Electric Power Co
13 – Heating plant
14 – Btu per sq ft per hr
15 – 1800 rpm
16 – Each one-third capacity
17 – Driven by generator shaft

18 – Semi-outdoors
19 – Revised data, previously listed 9-55
20 – Nameplate rating
21 – Replaces 25-cycle unit
22 – Future unit
23 – Fluid coke
24 – Automatic extraction at one point
25 – Normally serves adjacent refinery
26 – Sub-bituminous
27 – Gas turbine exhaust supplies boiler air
28 – Jointly owned with California Electric Power Co
29 – Semi-bituminous

1957 Design Survey of Typical New

Compiled by Althea Thornton, Assistant Editor

Company	Location	Plant name	Consulting engineers	Unit No., new units	First operation new units	Throttle pressure, psig	Steam temp, F		BOILERS					
							Throttle	Reheat	Number	Capacity, each, 1000 lb per hr	Manufacturer	Surface, 1000 sq ft		
												Boiler & WW	Superheater	Reheater
Boston Edison Co	Everett, Mass.	Mystic	Jackson & Moreland Inc	5	8-59	1800	1000	1000	1	935	CE	26.0	78.1	14.0
California Electric Power Co	San Bernardino, Calif.	San Bernardino	Fluor Corporation	2	4-58	1800	1000	1000	1[9]	475	CE	13.2	31.4	6.3
	Yuma, Ariz.	Yuma Axis	Bechtel Corporation	1	4-59	1800	1000	1000	1[9]	575	CE	14.1	–	–
	Highgrove, Calif.	Highgrove	Fluor Corporation	4	–	1250	950	–	1	425	CE	16.7	12.1	–
Central Illinois Light Co	Peoria, Ill.	La Marsh	Commonwealth Associates, Inc	1	4-60	1800	1000	1000	1	850	RS	46.6	43.0	45.1
Central Power & Light Co	Calallen, Texas	Lon C Hill	Sargent & Lundy	3	4-59	1800	1000	1000	1[9]	1100	BW	13.0	58.9	13.1
Connecticut Light & Power Co	Devon, Conn.	Devon	United Engineers & Constructors	8	9-58	1800	1000	1000	1	800	CE	21.0	68.5	11.3
Dallas Power & Light Co	Dallas, Texas	North Lake	Ebasco Services Inc	1	1-60	1800	1000	1000	1[9]	1200	RS	40.8	53.0	41.8
				2	1-61	1800	1000	1000	1[9]	1200	–	–	–	–
Delaware Power & Light Co	Indian River, Del.	Indian River	United Engineers & Constructors	2	1959	1800	1000	1000	1	625	BW	12.1	33.9	21.6
	Wilmington, Del.	[28]	C F Braun & Co	–	9-56	1300	950	–	3	500	RS	34.7	24.5	–
Florida Power Corporation	St. Petersburg, Fla.	Paul L Bartow	Black & Veatch	2	11-60	1800	1000	1000	1	900	CE	15.1	60.1	16.5
	Enterprise, Fla.	George E Turner	Black & Veatch	4	5-59	1450	1000	1000	1	600	RS	24.4	35.0	16.5
Georgia Power Co	Brunswick, Ga.	McManus	Southern Services Inc	2	5-59	1800	1000	1000	1	580	BW	9.1	–	–
Gulf Power Co	Pensacola, Fla.	Crist	Southern Services Inc	4	5-59	1800	1000	1000	1	582	CE	14.1	48.8	7.7
Kansas Gas & Electric Co	Wichita, Kan.	Murray Gill	Ebasco Services Inc	4	5-59	1800	1000	1000	1[9]	800	FW	13.2	14.0	24.4
	nr Wichita, Kan.		Ebasco Services Inc	1	3-61	1800	1000	1000	1[9]	1020	RS	34.8	43.7	55.2
Kansas Power & Light Co	Lawrence, Kan.	Lawrence	Black & Veatch	4	4-59	1800	1000	1000	1[9]	842	CE	15.9	58.7	15.6
Long Island Lighting Co	Port Jefferson, N.Y.	Port Jefferson	Ebasco Services Inc	4	10-60	1800	1000	1000	1[16]	1150	CE	51.4	78.1	13.0
	Island Park, N.Y.	Edward F Barrett	Ebasco Services Inc	6	10-61	1800	1000	1000	1[16]	1150	CE	51.4	78.1	13.0
Louisiana Power & Light Co	Sterlington, La.	Sterlington	Ebasco Services Inc	6[1]	4-57	1800	1000	1000	1[9]	1550	RS	50.0	71.2	62.7
Louisville Gas & Electric Co	Louisville, Ky.	Cane Run	Pioneer Service & Engrg Co	3	4-58	1800	1000	1000	1	950	FW	29.9	15.8	48.2
Mississippi Power Co	Handsboro, Miss.	Gulf Coast	Southern Services Inc	2	5-60	1800	1000	1000	1	582	CE	14.1	48.8	7.7
Montaup Electric Co	Somerset, Mass.	Montaup	Stone & Webster Engrg Corp	6	3-59	1800	1000	1000	1	800	CE	13.3	51.0	11.1
Northern States Power Co	St. Paul, Minn.	High Bridge	Pioneer Service & Engrg Co	6	8-59	1800	1000	1000	1	1200	BW	24.9	76.2	49.4
Public Service Co of Indiana, Inc	New Albany, Ind.	New Albany	Sargent & Lundy	1	3-58	1800	1000	1000	1	1000	RS	59.9	54.7	60.4
				2	10-58	1800	1000	1000	1	1000	RS	59.9	54.7	60.4
				3	1-60	1800	1000	1000	1	1000	RS	59.9	54.7	60.4
				4	10-60	1800	1000	1000	1	1000	RS	59.9	54.7	60.4
Rochester Gas & Electric Corp	Rochester, N.Y.	Station 3	Gilbert Associates Inc	12	10-59	1800	1050	1000	1	560	CE	16.0	54.0	8.4
Texas Power & Light Co	McLennan County, Texas	Lake Creek	Ebasco Services Inc	2	3-59	1800	1000	1000	1[9]	1600	FW	36.4	21.4	59.7
West Penn Power Co	Reesedale, Pa.	Armstrong	Sanderson & Porter	2	9-59	1800	1000	1000	1	1200	FW	27.7	22.8	59.6
Savannah Electric & Power Co	Port Wentworth, Ga.	Port Wentworth	Stone & Webster Engrg Corp	1	4-58	1465	1000	1000	1[16]	375	CE	11.9	17.6	6.0
Atlantic City Electric Co	Penns Grove, N.J.	Deepwater	Gibbs & Hill Inc	1	1958	1450	1000	1000	1	616	BW	9.7	–	–
Central Louisiana Electric Co Inc	St. Landry, La.	Coughlin	Sargent & Lundy	6	4-61	1450	1000	1000	1[9]	700	BW	8.7	–	–
Columbus & Southern Ohio Electric Co	Conesville, Ohio	Conesville	Ebasco Services Inc	1	10-58	1450	1000	1000	1[9]	1000	BW	19.8	100.4	17.2
				2[7]	12-57	1450	1000	1000	1[9]	1000	BW	15.8	98.5	16.0
Florida Power & Light Co	Ft. Myers, Fla.	Ft. Myers	Ebasco Services Inc	1	12-58	1450	1000	1000	1[9]	1100	BW	10.0	44.4	21.3
	Lake Monroe, Fla.	Sanford	Ebasco Services Inc	3	5-59	1450	1000	1000	1[9]	1100	BW	10.0	44.4	21.3
Iowa Power & Light Co	Council Bluffs, Iowa	Council Bluffs	Black & Veatch	2	10-58	1450	1000	1000	1[9]	630	CE	12.5	33.9	8.7
Iowa Public Service Co	Waterloo, Iowa	Maynard	Ebasco Services Inc	7	10-58	1450	1000	–	1[9]	460	RS	32.6	27.7	0
Kentucky Utilities Co	Central City, Ky.	Green River	Sargent & Lundy	4	7-59	1450	1000	1000	1	750	BW	16.9	37.4	26.9
Minnesota Power & Light Co	Cohasset, Minn.	Clay Boswell	Ebasco Services Inc	2	9-59	1450	1000	1000	1[9]	500	RS	16.6	30.1	25.7
Otter Tail Power Co	Fergus Falls, Minn.	Hoot Lake	Burns & Roe Inc	2	9-59	1450	1000	1000	1	420	CE	8.4	–	–
El Paso Electric Co	nr El Paso, Texas	Rio Grande	Stone & Webster Engrg Corp	7	6-58	1450	1000	1000	1	350	BW	8.7	10.8	4.6
Pacific Power & Light Co	Glenrock, Wyo.	Dave Johnston	Ebasco Services Inc	1[1]	10-58	1450	1000	1000	1[9]	750	BW	12.7	–	–
Potomac Edison Co	Williamsport, Md.	R Paul Smith	Sanderson and Porter	4	9-58	1450	1000	1000	1	600	CE	9.9	36.8	8.3
Public Service Co of Colorado	Denver, Colo.	Cherokee	Ebasco Services Inc	1	7-57	1450	1000	1000	1[16]	850	BW	28.9	46.2	27.9
				2	4-59	1450	1000	1000	1[16]	852	BW	36.4	38.7	28.6
	Cameo, Colo.	Cameo	Steams Roger Mfg Co	1	7-57	850	900	–	1[16]	215	BW	17.5	8.9	0
Southwestern Gas & Electric Co	Mooringsport, La.	Lieberman	Sargent & Lundy	4	5-59	1450	1000	1000	1[9]	725	CE	23.0	37.7	10.4
Southwestern Public Service Co	Borger, Texas	Station B		1	6-60	1450	1000	1000	1[16]	800	CE	–	–	–
Tampa Electric Co	Tampa, Fla.	Gannon	Stone & Webster Engrg Corp	1[10]	7-57	1450	1000	1000	1[9]	950	BW	14.6	–	–
				2	9-58	1450	1000	1000	1[9]	950	BW	17.3	54.3	16.2
Tucson Gas Electric Light & Power Co	Tucson, Ariz.	No. 4	Sanderson & Porter	1	5-58	1450	1000	1000	1[9]	575	CE	13.6	19.8	5.0
				2	1-60	1450	1000	1000	1[9]	575	CE	13.6	19.8	5.0
United Illuminating Co	Bridgeport, Conn.	Bridgeport Harbor	Jackson & Moreland	1[10]	9-57	1450	1000	1000	1[16]	575	BW	12.1	36.8	10.9
Utah Power & Light Co	Castle Gate, Utah	Carbon	Bechtel Corp	2	7-57	1450	1000	1000	1	765	CE	37.2	47.9	10.2
West Texas Utilities Co	Haskell, Texas	Paint Creek	Sargent & Lundy	3	5-59	1450	1000	1000	1[9]	350	BW	8.6	13.5	4.5
	Girvin, Texas	Rio Pecos	Sargent & Lundy	5[27]	5-59	850	900	–	1[9]	300	FW	23.3	4.2	0
Cambridge Electric Light Co	Cambridge, Mass.	Kendall Square	Gilbert Associates Inc	3	6-58	1300	900	–	–	–	–	–	–	–
Atlantic City Electric Co	Deepwater, N.J.	Deepwater	Gibbs & Hill Inc	7	3-57	1285	760	–	1[9]	550	CE	8.6	11.0	0
Hawaiian Electric Co Ltd	Honolulu, Hawaii	Honolulu		9	12-57	1250	950	–	1	485	BW	7.5	18.3	0
	Waiau, Oahu	Waiau	Bechtel Corp	5	10-59	1250	950	–	1[9]	485	BW	7.5	18.3	0
Missouri Public Service Co	Sibley, Mo.		Burns & McDonnell Engrg Co	1	1960	1250	950	–	1	450	BW	8.5	–	0
Public Service Co of New Mexico	Albuquerque, N.M.	Reeves	Steams Roger Mfg Co	2	11-58	1250	950	–	1[9]	425	BW	4.1	4.2	0
United Gas Improvement Co	Hunlock Creek, Pa.	Hunlock	United Engineers & Constructors	3	12-59	1250	950	–	1	400	FW	17.9	14.5	0
Calgary Power Ltd	Wabamun, Alberta, Canada	Wabamun	Montreal Engineering Co Ltd	1	9-58	850	900	–	1	625	BWG	39.4	28.7	0
Central Power & Light Co	Bates, Texas	J L Bates	Sargent & Lundy	1	4-58	850	900	–	1[9]	630	BW	32.5	15.8	0

A – Anthracite
AC – Allis-Chalmers Mfg Co
Ad – Admiralty
AdD – Admiralty D
AdI – Admiralty, Inhibited
Al – Aluminum
AlB – Aluminum Bronze
AlBr – Aluminum Brass
AlBrI – Inhibited Aluminum Brass
AsAd – Antimonial Admiralty
AsAd – Arsenical Admiralty
AsAdB – Arsenical Admiralty Bronze

AsAdI – Inhibited Arsenical Admiralty
AsCo – Arsenical Copper
B – Variable pitch blade
BB – Brown Boveri Corp
Br – Brass
BW – Babcock & Wilcox Co
BWG – Babcock-Wilcox & Goldie-McCulloch Ltd
C – Coal, bituminous
CE – Combustion Engineering Inc
CES – Combustion Engineering-Superheater Ltd

CNi – Cupro nickel
Con – Condenser deaeration
CP – C A Parsons & Co, Ltd
Cy – Cyclone furnace
D – Damper
DB – Dry bottom
Du – Dual turbine and motor drive
EC – Erie City Iron Works
EE – English Electric Co Ltd
EL – Elliott Co
FW – Foster Wheeler Corp
G – Natural Gas

GE – General Electric Co
Hy – Hydraulic coupling
L – Lignite
M – Motor drive
Ma – Magnetic coupling
Mp – Two motors per fan
MV – Metropolitan-Vickers Electrical Co Ltd
N – None
O – Oil
P – Pulverized
PAd – Phosphorized Admiralty

Steam Central-Station Installations

Furnace volume, 1000 cu ft	Heat release, 1000 Btu per cu ft per hr	Furnace bottom	Economizer surface per boiler, 1000 sq ft	Air-heater surface per boiler, 1000 sq ft	Air-heater type	F-D FANS		I-D FANS		Firing	FUELS			FEED PUMPS		TURBINES					Full-load deaerator pressure, psia	CONDENSERS			Total boiler capacity incl new units, 1000 lb per hr	Total generator capability incl new units, 1000 kw
						Drive	Air-flow control	Drive	Gas-flow control		Type	Heating value 1000 Btu per lb	Ash-softening temperature, F	Drive	Flow control	Number	Capability, each 1000 kw	Manufacturer	Backpressure, psia	No. bleed points		Surface, 1000 sq ft	No. water passes	Tube material		
58.9	21.3	DB	17.5	68.3	Re	M	V	M	S	P,O	C,O	13.5	2200	3M	R,Hy	1	125	GE	0.75	6	100	75	1	AlB	3250	400
30.8	21.4	–[6]	5.0	62.2	Re	M	V	–[6]	–	O,G	O,G	18.3	–	2M	R	1[18]	60	GE	1.0	5	67	42.5	2	AsCu	950	132
31.5	25.8	–[6]	13.0	109.5	Re	M	V,Hy	–[6]	–	O,G[22]	O,G	1078[7]	–	2M	Hy	1[18]	75	GE	1.0	5	Con	45	2	AsCu	575	75
23.4	23.9	DB	13.9	63.4	Re	M	V	M	V	O,G	O,G	18.3	–	2M	R	1[18]	44	GE	1.0	5	90	35	2	AsCu	1490	156
73.5	16.2	DB	13.2	178.8	Re	M	V	M	V	P	C	9.8	2000	2M	R	1	125	GE	1.75	6	Con	65	2	AdI	850	125
51.3	31.0	–[6]	20.1	185.2	Re	M	V	–[6]	–	G	G	1040[7]	–	3M	Hy	1[18]	150	GE	1.25	6	105	80	2	AsAd	2360	282
68.5	14.5	DB	12.6	191.2	Re	M	V	M	D	P	C	13.2	2200	3M	R	1	100	WE	1.75	6	Con	75	2	AlBr	–	497
51.9	32.4	–[6]	19.2	168.0	Re	M	V	–[6]	–	G	G	1078[7]	–	2M	S,Hy	1[18]	156	GE	1.75	6	165	70	1	Ad	1200	156
–	–	–[6]	–	–	Re	M	V	–[6]	–	G	G	1078[7]	–	2M	S,Hy	1[18]	156	WE	1.75	6	165	70	1	Ad	2400	313
47.6	17.0	DB	17.3	166.2	Re	M	V	M	D	P,O	C,O	13.2	2000	2M	Hy	1	80	WE	0.75	6	87	50	1	AlBr	1250	150
36.5	–	ST	–	45.9	Re	M	V	M	V	Cy	O,G[23]	–	–	3M	R	2	32	GE	1.25	4[24]	–	16	2	–	1500	64
76.5	–	DB	31.3	163.4	Re	M	V	M	D	O,G	O,G	18.2	–	2M	Hy	1	121	GE	1.0	6	77	80	1	CuNi	1800	242
28.3	–	–[6]	12.2	101.2	Re	M	V	M	D	O,G	O,G	18.2	–	2M	R	1	75	WE	1.0	6	57	50	2	AdI	1750	188
47.6	–	DB	17.3	166.2	Re	M	Hy	M	Hy	P	C,O	12.0	2100	2M	Hy	1	75	AC	1.0	4	74	60	2	AlBr	1007	105
42.4	18.2	DB	12.2	200.6	Re	M	Hy	M	Hy	P	C	11.9	2550	2M	Hy	1	75	AC	1.0	4	74	60	2	AlBr	1367	150
44.3	25.1	DB	37.0	180.4	Re	M	V	M	D	O,G	O,G	1000[7]	–	3M	R	1[18]	116	GE	1.75	5	25	65	2	Ad	2675	362
54.0	27.0	DB[6]	14.0	168.8	Re	M	D	–[6]	–	G,O[22]	G,O	1035[7]	–	2M	R	1[18]	165	WE	1.25	6	124	75	2	Ad	1070	165
83.0	–	DB	25.8	71.5	Re	M	V	M	S,D	P,O,G	C,O,G	11.5	2250	2M	R	1	134	GE	0.75	6	Con	70	1	Ad	1700	235
113.3	13.8	DB	26.9	114.5	Re	M	V	M	D	P,O	C,O	12.9	2000	2M	R	1[18]	156[20]	GE	0.75	6	Con	70	1	AlBr	3590	475
113.3	13.8	DB	26.9	114.5	Re	M	V	M	D	P	C	12.9	2000	2M	R	1[18]	156[20]	GE	0.75	6	Con	70	1	AlBr	2650	370
85.5	–	–[6]	35.9	344.6	Re	M	V	–[6]	–	G	G	970[7]	–	3M	Hy	1[18]	220	GE	0.75	7	Con	–	2	–	3215	357
81.5	16.2	DB	34.3	148.0	Re	M	Hy	M	Hy	P,G	C,G	11.3	2050	3M	R,Hy	1	125	GE	0.75	5	125	80	2	AdI	2623	325
42.4	18.9	DB[6]	12.2	200.6	Re	M	Hy	–[6]	–	G	G	1000[7]	–	2M	Hy	1	75[20]	GE	1.0	4	69	65	2	AlBr	1164	150
68.5	–	DB	30.5	–	Re	M	D	M	Hy	P,O	C,O	11.6	–	3M	R	1	100[20]	GE	1.75	6	–	75	2	CuNi	3000	332
91.7	17.3	DB	11.3	229	Re	M	S,Ma	M	S,Ma	P,G	C,G	10.4	1990	3M	R	1	172	GE	0.75	6	118	105	2	PAd	4240	497
96.6	14.1	DB	16.6	389.6	Re	M	V	M	S,Hy	P	C	10.6	1900	3M	Hy	1	150	AC	0.75	6	105	85	2	AsAd	1000	150
96.6	14.1	DB	16.6	389.6	Re	M	V	M	S,Hy	P	C	10.6	1900	3M	Hy	1	150	AC	0.75	6	105	85	2	AsAd	2000	300
96.6	14.1	DB	16.6	389.6	Re	M	V	M	–	P	C	10.6	1900	3M	R,Hy	1	150	AC	0.75	6	105	85	2	AsAd	3000	450
96.6	14.1	DB	16.6	389.6	Re	M	V	M	–	P	C	10.6	1900	3M	R,Hy	1	150	AC	0.75	6	105	85	2	AsAd	4000	600
54.1	14.4	DB	11.0	115.8	Re	M	V	M	V	P	C	13.2	2100	2M	R,Hy	1	83.5	GE	0.5	6	Con	50	2	AsAd	2250	225
90.0	25.0	–[6]	52.9	241.6	Re	M	D	–[6]	–	G	G	1078[7]	–	2M	R	1[18]	200	WE	1.75	7	125	90	1	AsCu	2316	275
112.2	14.5	DB	61.7	201.6	Re	M	V	M	V	P	C	11.1	2280	2M	R	1	156[20]	WE	1.75	7	53	75	2	–	2400	321[20]
28.8	–	DB	11.4	56.1	Re	M	V	M	V	P	C	12.6	2400	2M	Hy	1	50	GE	1.0	5	75	35	2	Ad	375	50
–	–	ST[6]	–	–	Re	M	D	–[6]	–	Cy	C	13.2	2300	2M	R	1	83	GE	0.75	5	80	42.5	1	AdI	3376	323
33.0	–	–[6]	–	–	Re	M	D	–[6]	–	G	G	1000[7]	–	2M	Hy	1[9,9]	100	WE	1.75	5	–	–	–	–	885	213
48.0	28.0	ST[6]	–	287	Re	M	V	–[6]	–	Cy	C	11.3	2200	2M	R	1[18]	125	WE	1.75	5	108	75	2	AsAd	2000	250
48.0	27.7	–[6]	0	285	Re	M	V	–[6]	–	Cy	C	11.3	2200	3M	R	1[18]	135	GE	0.75	6	150	75	2	Ad		
61.1	–	DB	13.3	144	Re	M	D	M	D	O	O	18.3	–	3M	R	1[18]	160	WE	1.25	6	Con	80	1	AlBr	1100	160
61.1	–	DB	13.3	144	Re	M	D	M	D	O	O	18.3	–	3M	R	1[18]	160	WE	1.25	6	Con	80	1	AlBr	1495	192
56.3	15.3	DB	29.4	151.4	Re	M	V	M	Ma	P,G	C,G	11.2	1995	3M	R	1	82	GE	0.75	5	60	55	2	AsCu	1055	126
36.0	15.9	DB	5.7	76.3	Re	M	D,V	M	D,V	P,G	C,G	10.1	1900	2M	R	1	50	GE	0.75	5	73	35	2	AdI	1200	110
52.8	21.1	DB	14.6	136.6	Re	M	V	M	D,Hy	P	C	11.4	1950	3M	S,Hy	1[18]	100	WE	0.75	5	100	70	2	Ad	2055	220
39.0	17.7	DB	9.3	97.7	Re	M	V	Mp	D	P	C	11.5	2100	2M	Hy	1[18]	65	GE	1.25	5	50	30	1	Ad	1000	130
31.0	19.1	DB	–	157.1	Re	M	D,Hy	M	D,Hy	P	L	6.5	2290	2M	Hy	1	53.5	GE	1.75	5	64	30	2	AsAdI	520	69
16.7	29.8	–[6]	9.7	70.0	Re	M	V	–[6]	–	G	G	1090[7]	–	2M	R	1	44	GE	1.0	5	80	25	2	AsAd	2400	244
79.5	13.3	DB	26.0	76.3	Re	M	D	M	D	P	C[26]	7.8	2290	2M	R	1[9,9]	100	GE	1.75	5	100	50	2	AsAd	750	100
47.0	17.1	DB	22.3	91.6	Re	M	V	M	D	P	C	12.5	2500	2M	R	1	75	AC	0.75	5	24	40	2	Ad	1650	168
81.3	13.0	DB	28.1	281	Tu	M	V	M	V	P, L,G	C[26], L,G	9.3	2090	3M	R	1	100	GE	0.75	8	40	45	1	PAd	850	100
79.2	14.3	DB	20.1	281	Tu	M	V	M	V	P, L,G	C[26], L,G	9.3	2090	3M	–	1	110[20]	WE	0.75	8	40	45	1	PAd	1702	210
16.5	17.0	DB	–	61.9	Tu	M	V	M	V	P	C	11.6	2200	3M	R	1	22	WE	0.8	4	25	12	2	PAd	215	22
60.3	17.1	DB[6]	18.0	135.6	Re	M	V	–[6]	–	G	G	1041[7]	–	2M	R,Hy	1	100[20]	WE	0.75	5	70	65	2	AnAd	1950	250
–	–	–[6]	–	–	Re	M	V	–[6]	–	G	G	1000[7]	–	2M	Hy	1	100[20]	GE	0.75	5	80	75	2	AsAd	800	100
–	–	ST[6]	–	131.8	Re	M	V	–[6]	–	Cy	C	11.8	2050	3M	R	1	130	GE	1.0	5	Con	75	1	CuNi		
–	–	ST[6]	10.0	–	Re	M	D,V	–[6]	–	Cy	C	11.8	2250	3M	R	1	120	AC	1.75	5	Con	75	1	–	1900	240
36.0	28.3	–[6]	19.4	136.1	Re	Mp	S,V	–[6]	–	G	G	1060[7]	–	2M	Hy	1	82	WE	0.9	5	25	40	2	AdI		
36.0	28.3	–[6]	19.4	136.1	Re	Mp	S,V	–[6]	–	G	G	1060[7]	–	2M	Hy	1	82	GE	0.9	5	25	40	2	AdI	1150	164
30.8	24.6	ST[6]	9.4	198.4	Re	M	V	–[6]	–	Cy,O	C,O	13.6	2300	2M	R	1[5]	82	GE	0.75	6	60	45	1	AlBr	575	82
67.4	13.7	DB	24.6	–	Re	M	D,V	M,MT	D,V	P	C	12.3	2228	2M	S,Hy	1[5]	100	WE	1.25	5	78	65	2	–	1385	166
–	30.0	DB[6]	7.7	71.0	Re	M	V	–[6]	–	G	G	1080[7]	–	2M	Hy	1	50	GE	1.75	5	70	30	2	Ad	950	125
12.0	31.2	DB[6]	16.3	–	–	M	B	–[6]	–	G,O	G,O	740[7]	–	2M	R	1	33	AC	1.25	5	12	30	2	AsAd	–	56
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	25	WE	0.75	4	20	20	2	AlBr	780	77
–	–	DB	22.8	61.6	Re	M	V	M	V	O	O	–	–	2M	R	1	25	GE	18	3	–	0	–	–	3019	238
20.0	28.8	DB	11.9	64.0	Re	Mp	S,D,V	M	D,V	O	O	17.7	–	3M	R	1	50	WE	1.0	5	73	40	1	AlBr	2182	205
20.0	28.5	–[6]	11.9	58.3	Re	Mp	S,D,V	–[6]	–	O	O	17.7	–	2M	R	1[18]	50	WE	1.0	5	Con	40	1	AsAlBr	1650	185
18.3	–	–[6]	6.9	110.1	Tu	M	V	–[6]	–	Cy	C	10.4	1900	2M	R	1[5]	44	WE	0.75	5	Con	35	2	Ad	450	44
18.0	–	–[6]	–	78	Re	Mp	V	–[6]	–	O,G	O,G	1000[7]	–	2M	Hy	1[5]	49	WE	0.75	5	65	35	2	PAd	425	49
60.9	10.2	DB	3.7	114.6	Re	M	V	M	D	P	A	8.8	2600	2M	Hy	1[5]	44	WE	0.75	5	90	35	2	Ad	1050	93
56.9	14.1	DB	21.8	76.4	Re	M	D	M	D	G	G	1070[7]	–	2M	R	1	66	MV	0.75	5	150	46	2	Ad	1250	140
27.9	30.0	–[6]	–	155.3	Tu	M	D	–[6]	–	O,G	O,G	1040[7]	–	2M	R	1[5]	66	WE	1.25	4	100	60	2	Ad	630	66

Pl – Plate
R – Regulator
Re – Regenerative
RS – Riley Stoker Corp
S – Speed control
SiB – Silicon Bronze
SP – Springfield Boiler Co
SS – Spreader stoker
ST – Slag tap
T – Turbine drive
TG – Traveling grate stoker
Tu – Tubular

UF – Underfeed stoker
UI – Union Iron Works
V – Vane control
WE – Westinghouse Electric Corp
Wi – Wickes Boiler Co
(823) – Stoker grate area, sq ft
1 – Revised data, previously listed 9-56
2 – Once-through boiler
3 – Double reheat
4 – Hp 3600 rpm, lp 1800 rpm
5 – Preferred standard
6 – Pressurized furnace

7 – Btu per cu ft
8 – Two, driven by main unit shaft
9 – Outdoor installation
10 – Half capacity
11 – Hp 3600 rpm, lp 3600 rpm
12 – Units 1 and 2 listed under Appalachian Electric Power Co
13 – Heating plant
14 – Btu per sq ft per hr
15 – 1800 rpm
16 – Each one-third capacity
17 – Driven by generator shaft

18 – Semi-outdoors
19 – Revised data, previously listed 9-55
20 – Nameplate rating
21 – Replaces 25-cycle unit
22 – Future coal
23 – Fluid coke
24 – Automatic extraction on one point
25 – Normally serves adjacent refinery
26 – Sub-bituminous
27 – Gas turbine exhaust supplies boiler air
28 – Jointly owned with California Electric Power Co
29 – Semi-bituminous

1957 Design Survey of Typical New

Compiled by Althea Thornton, Assistant Editor

Company	Location	Plant name	Consulting engineers	Unit No., new units	First operation new units	Throttle pressure, psig	Steam temp, F: Throttle	Steam temp, F: Reheat	BOILERS: Number	BOILERS: Capacity, each, 1000 lb per hr	BOILERS: Manufacturer	BOILERS: Surface, 1000 sq ft: Boiler & WW	BOILERS: Surface, 1000 sq ft: Superheater	BOILERS: Surface, 1000 sq ft: Reheater
Interstate Power Co	Dubuque, Iowa	Dubuque	Sargent & Lundy	4	9-59	850	900	–	1	400	RS	45.4	18.5	0
Newfoundland Light & Power Co, Ltd	St. John's, Newfoundland		Montreal Engineering Co, Ltd	2	9-59	850	900	–	1	190	BWG	7.8	6.0	0
Pacific Gas & Electric Co	Eureka, Calif.	Humboldt Bay	Bechtel Corp	2[3]	10-58	850	900	–	1[9]	475	RS	35.4	16.2	0
Saskatchewan Power Corp	Saskatoon, Sask.	So.Sask. River	R A Hanright	1	7-58	850	900	–	1[10]	600	FW	55.6	11.8	0
				2	7-59	850	900	–	1[10]	600	FW	55.6	11.8	0
	Estevan, Sask.	Boundary Dam	Ewbank & Partners (Canada) Ltd	1	10-58	850	900	–	1	600	BWG	30.2	18.5	0
				2	10-59	850	900	–	1	600	CE	29.8	13.9	0
Southern Colorado Power Co	Canon City, Colo.	Clark	Stearns-Roger Mfg Co	2	3-59	850	900	–	1	210	BW	24.0	–	0
Canadian Utilities, Ltd	St. of Forestburg, Alberta	Battle River	Haddin Davis & Brown	1	3-57	600	825	–	1	350	CE	28.6	–	0
Central Kansas Power Co	Hays, Kansas	Hays	Black & Veatch	2	7-57	400	750	–	1	125	BW	–	–	0
Maritime Electric Co, Ltd	Charlottetown, PEI, Canada		Montreal Engineering Co	1	12-56	400	750	–	1	100	BW	14.2	–	0
New Bedford Gas & Edison Light Co	New Bedford, Mass	Cannon St	NEGEA Service Corp	7	7-57	200	525	–	1	100	BW	146.5	5.1	0
				8	7-57	200	525	–	1	100	BW	146.5	5.1	0

MUNICIPAL, FEDERAL AND COOPERATIVE INSTALLATIONS

Tennessee Valley Authority	Bridgeport, Ala.	Widow's Creek		–	1960	2400	1050	1000	1	3850	CE	–	–	–
	Gallatin, Tenn.	Gallatin		3	12-58	2000	1050	1050	1	1960	CE	38.1	186.0	33.5
				4	9-59	2000	1050	1050	1	1960	CE	38.1	186.0	33.5
	Waverly, Tenn.	Johnsonville		9	4-59	2000	1050	1000	1	1100	FW	26.4	23.0	41.3
				10	6-59	2000	1050	1000	1	1100	FW	26.4	23.0	41.3
Hydro-Electric Power Comm of Ontario	Toronto, Ontario	R. L. Hearn	Stone & Webster Engrg Corp	6	1959	1800	1000	1000	1	1350	CE	–	–	–
				7	1960	1800	1000	1000	1	1350	CE	–	–	–
				8	1960	1800	1000	1000	1	1350	–	–	–	–
Omaha Public Power District	Omaha, Neb.	North Omaha	Pioneer Service & Engrg Co	3	5-59	1800	1000	1000	1[10]	750	CE	20.5	68.6	12.9
Salt River Power District	Glendale, Ariz.	Agua Fria	Bechtel Corp	1	5-58	1800	1000	1000	1[9]	750	RS	31.4	41.3	33.4
				2	5-57	1800	1000	1000	1[9]	750	RS	31.4	41.3	33.4
San Antonio Public Service Board	San Antonio, Texas	Leon Creek	Gibbs & Hill, Inc	4	5-59	1525	1000	1000	1	800	BW	13.0	24.9	18.0
		Mission Road	Gibbs & Hill, Inc	3	5-58	1450	1000	1000	1	750	BW	11.4	23.1	16.4
Dairyland Power Cooperative	Alma, Wis.	Alma	Vern E Alden Co	5	10-59	1450	1000	1000	1	580	RS	35.4	33.5	29.4
E. Kentucky Rural Electric Coop. Corp	Ford, Ky.	Wm. C Dale	Stanley Engineering Co	4	9-61	1250	950	–	1[10]	623	RS	55.1	26.0	0
City of Jacksonville	Jacksonville, Fla.	Talleyrand	Reynolds, Smith & Hills	9	1-58	1250	950	–	1[10]	450	BW	–	–	0
		Southside	Reynolds, Smith & Hills	4	1960	1250	950	–	1	450	BW	–	–	0
City Utilities of Springfield	Kissick, Mo.	James River	Burns & McDonnell Engrg Co	3	1960	1250	950	–	1[9]	440	RS	40.2	21.0	0
Plains Electric G & T Coop, Inc	Algodones, N. Mex.	Algodones	Laramore, Douglass & Popham, Inc	3	12-58	870	910	–	1	160	SP	14.8	6.7	0
Alabama Electric Cooperative, Inc	Gantt, Ala.	McWilliams	Burns & McDonnell Engrg Co	3	5-59	850	900	–	1[9]	235	BW	19.7	–	0
Brazos Electric Power Coop, Inc	East of Weatherford, Tex.			1	6-58	850	900	–	1	165	BW	–	–	0
				2	7-58	850	900	–	1	180	BW	–	–	0
City of Bryan	Bryan, Texas	Municipal	Lutz & May Co	4	6-58	850	900	–	1[9]	220	WI	19.8	5.8	0
Corn Belt Power Cooperative	Spencer, Iowa	Spencer	Stanley Engineering Co	1	1961	850	900	–	1	335	–	–	–	0
Eastern Iowa Light & Power Cooperative	Montpelier, Iowa	Montpelier	Stanley Engineering Co	1	1-60	850	900	–	1	215	–	–	–	0
City of Gainesville	Gainesville, Fla.		Ebaugh & Goethe	6	1-58	850	900	–	1	165	BW	12.4	–	0
City of Hamilton	Hamilton, Ohio	Municipal	Emery, Marker & Campbell	6	1959	850	900	–	1	195	WI	–	–	0
				7	1959	850	900	–	1	195	WI	–	–	0
Hastings Utilities	Hastings, Neb.	North Denver	Lutz & May Co	4	11-57	850	900	–	1	160	SP	14.6	7.2	0
City of Lubbock	Lubbock, Texas	Municipal	Nelson Miner & Co	6	9-57	850	900	–	1[9]	220	BW	10.6	4.8	0
Manitoba Hydro-Electric Board	Selkirk, Manitoba	Selkirk	Ewbank & Partners (Canada) Ltd	1	11-59	850	900	–	1	600	BWG	81.4	14.0	0
				2	11-59	850	900	–	1	600	BWG	81.4	14.0	0
City of Muscatine	Muscatine, Iowa	Municipal	Stanley Engineering Co	7	8-60	850	900	–	1[10]	235	WI	18.7	8.5	0
Peru Board of Public Works & Safety	Peru, Ind.	Municipal	Pfeifer & Schultz	3	–	850	900	–	1	220	SP	15.2	13.0	0
Rushmore G & T Cooperative, Inc	Lead, So. Dakota	Kirk	Stearns-Roger Mfg Co	4	9-56	850	900	–	1	150	CE	17.6	6.2	0
Key West Utility Board	Key West, Fla.	Municipal	R W Beck and Assoc	3	12-57	825	950	–	1	165	CE	13.0	5.6	0
City of Reading	Reading, Ohio	Municipal		–	1958	650	835	–	1	70	BW	2.0	1.9	0
Nova Scotia Power Commission	Trenton, N.S., Canada	Trenton		4	1959	630	815	–	1	220	BW	29.6	7.5	0
City of Jonesboro	Jonesboro, Ark.	Municipal	Burns & McDonnell Engrg Co	6[1]	1958	625	830	–	1	125	BW	7.9	–	0
City of Crawfordsville	Crawfordsville, Ind.	Municipal	Stanley Engineering Co	4	12-55	600	825	–	1	125	RS	14.0	3.8	0
Southwestern Federated Power Corp	Creston, Iowa	Summit Lake	Stanley Engineering Co	3	10-57	600	825	–	1	100	SP	8.9	3.3	0
Sikeston Board of Public Works	Sikeston, Mo.	Municipal	Burns & McDonnell Engrg Co	1	2-59	600	825	–	1	60	EC	9.7	1.8	0
City of Spencer	Spencer, Iowa	Municipal	Stanley Engineering Co	4	2-60	600	825	–	1	100	–	–	–	0
Webster City	Webster City, Iowa	Municipal	Stanley Engineering Co	5	9-59	600	825	–	1	100	–	–	–	0
City of Orrville	Orville, Ohio	Municipal	H R Hadlow	11	6-57	415	750	–	1	150	BW	16.7	–	0
City of Chanute	Chanute, Kansas	Municipal	Universal Engrg Co, Inc	5	9-57	400	750	–	1	125	SP	11.5	3.1	0
City of Chillicothe	Chillicothe, Mo.	Municipal	Stanley Engineering Co	–	12-57	400	750	–	1	80	UI	8.1	2.4	0
Fairmont Water & Light Commission	Fairmont, Minn.	Municipal	Ellerbe & Company	5	9-58	400	750	–	–	–	–	–	–	0
McPherson Water & Electric Dept.	McPherson, Kan.	McPherson	F D Diehl	4/3	6-57	400	750	–	1	200	CE	17.1	3.3	0
City of Painesville	Painesville, Ohio	Municipal	H R Hadlow	–	–	400	750	–	1	150	RS	15.4	0.8	0
City of Schuyler	Schuyler, Neb.	Municipal	Lutz & May Co	–	6-58	400	750	–	1	60	CE	6.9	2.5	0

A – Anthracite
AC – Allis-Chalmers Mfg Co
Ad – Admiralty
AdD – Admiralty D
AdI – Admiralty, Inhibited
Al – Aluminum
AlB – Aluminum Bronze
AlBr – Aluminum Brass
AlBrI – Inhibited Aluminum Brass
AnAd – Antimonial Admiralty
AsAd – Arsenical Admiralty
AsAdB – Arsenical Admiralty Bronze

AsAdI – Inhibited Arsenical Admiralty
AsCu – Arsenical Copper
B – Variable pitch blade
BB – Brown Boveri Corp
Br – Brass
BW – Babcock & Wilcox Co
BWG – Babcock-Wilcox & Goldie-McCulloch Ltd
C – Coal, bituminous
CE – Combustion Engineering Inc
CES – Combustion Engineering-Superheater Ltd

CNi – Cupro nickel
Con – Condenser decoration
CP – C A Parsons & Co, Ltd
Cy – Cyclone furnace
D – Damper
DB – Dry bottom
Du – Dual turbine and motor drive
EC – Erie City Iron Works
EE – English Electric Co Ltd
EL – Elliott Co
FW – Foster Wheeler Corp
G – Natural Gas

GE – General Electric Co
Hy – Hydraulic coupling
L – Lignite
M – Motor drive
Ma – Magnetic coupling
Mp – Two motors per fan
MV – Metropolitan-Vickers Electrical Co Ltd
N – None
O – Oil
P – Pulverized
PAd – Phosphorized Admiralty

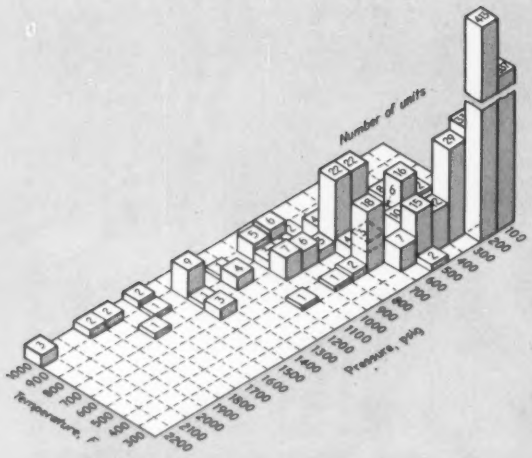
Steam Central-Station Installations

Furnace volume, 1000 cu ft	Heat release, 1000 Btu per cu ft per hr	Furnace bottom	Economizer surface per boiler, 1000 sq ft	Air-heater surface per boiler, 1000 sq ft	Air-heater type	F-D FANS: Drive	F-D FANS: Air-flow control	I-D FANS: Drive	I-D FANS: Gas-flow control	Firing	FUELS: Type	FUELS: Heating value 1000 Btu per lb	FUELS: Ash-softening temperature, °F	FEED PUMPS: Drive	FEED PUMPS: Flow control	TURBINES: Number	TURBINES: Capability, each 1000 kw	TURBINES: Manufacturer	TURBINES: Backpressure, psia	TURBINES: No. bleed points	Full-load steam pressure, psia	CONDENSERS: Surface, 1000 sq ft	CONDENSERS: No. water passes	CONDENSERS: Tube material	Total boiler capacity incl new units, 1000 lb per hr	Total generator capability incl new units, 1000 kw
34.8	16.5	DB	–	74.3	Re	M	V	M	Ma	P	C	10.5	1950	2M	R	1[9]	33	WE	0.75	4	–	23	2	Ad	1000	97
8.5	29.5	–[6]	–	15.6	Tu	M	V	–[6]	–	O	O	18.1	–	2M	R	1	20	MV	0.5	5	44	14	2	AlBr	300	30
19.6	32.3	–[6]	0	61.6	Re	M	D,V	–[6]	–	O,G	O,G	18.1	–	M,T	R	1[9]	50	WE	0.75	5	91	27.5	2	AlBr	950	100
51.4	16.5	DB	0	159.6	Re	M	V	M	D,Hy	P,O,G	C[26],O,G	8.5	2000	2M	R	1	66	BB	0.6	5	22	57	2	Br	600	66
51.4	16.5	DB	0	159.6	Re	M	V	M	D,Hy	P,O,G	C[26],O,G	8.5	2000	2M,T	R	1	66	EE	0.6	5	22	48	2	Br	1200	132
62.3	13.1	DB	23.8	138.0	Re	M	V	M	S,D,Hy	P	L	7.3	2050	3M	R	1	66	CP	0.75	5	–	48	2	Ad	600	66
46.2	17.4	DB	0	112.2	Re	M	V	M	S,D,Hy	P	L	7.3	2050	3M	R	1	66	CP	0.75	5	–	48	2	Ad	1200	132
14.1	19.0	–	4.3	24.0	Tu	Mp	S,D	Mp	S,D	SS	C	10.2	2200	2M	R	1[9]	22	GE	0.75	4	26	18	2	Ad	360	39
–	–	DB	0	82.1	Tu	M	V	M	Hy	P	C[26]	8.3	2155	2M	R	1	32	BB	0.65	4	Con	26.8	2	AdBr	350	32
–	–	–	–	–	Tu	M	D	M	D	O,G	O,G	950[7]	–	2M,T	–	1	8.5	WE	0.75	3	–	10	2	Ad	–	19
6.0	22.7	DB	–	–	Tu	M	D	M	D	O	O	18.4	–	3M	R	1	7.5	BB	0.77	4	Con	7.8	4	AdB	265	22
5.3	25.8	DB	0	0	–	–	D	–	D	O,G	O,G	18.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5.3	25.8	DB	0	0	–	–	D	–	D	O,G	O,G	18.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1[4]	500	GE	–	–	–	–	–	–	–	–
159.5	16.4	DB	94.9	330.6	Re	M	V	M	V	P	C	11.6	1950	2M	Hy	1	275	WE	1.0	8	135	100	1	Adl	7220	1050
159.5	16.4	DB	94.9	330.6	Re	M	V	M	V	P	C	11.6	1950	2M	Hy	1	275	WE	1.0	8	135	100	1	Adl		
79.2	18.1	DB	57.3	288.0	Re	M	V	M	D	P	C	11.6	1950	2M	Hy	1	150	GE	1.0	7	125	65	1	Adl	10,400	1350
79.2	18.1	DB	57.3	288.0	Re	M	V	M	D	P	C	11.6	1950	2M	Hy	1	150	GE	1.0	7	125	65	1	Adl		
–	–	DB	–	–	Re	M	–	M	–	P	C	13.5	2100	3M	Hy	1[4]	200	CP	0.75	6	95	90	1	Ad		
–	–	–	–	–	Re	M	–	M	–	P	C	13.5	2100	3M	Hy	1[4]	200	CP	0.75	6	95	90	1	Ad	8800	1200
–	–	–	–	–	Re	M	–	M	–	P	C	13.5	2100	3M	–	1[4]	200	CP	0.75	6	95	90	1	Ad		
73.5	–	DB	10.1	148.6	Re	M	D,Ma	M	D,Ma	P,G	C,G	11.3	1894	3M	Hy	1[9]	100	GE	1.0	5	82	65	2	AsCu	2075	260
45.0	23.9	DB[6]	13.5	117.0	Re	M	V	–[6]	–	O,G	O,G	18.1	–	3M	Hy	1[9]	100	GE	1.75	6	39.6	50	1	AsCu	1500	200
45.0	23.9	DB[6]	13.5	117.0	Re	M	V	–[6]	–	O,G	O,G	18.1	–	3M	Hy	1[9]	100	GE	1.75	6	39.6	50	1	AsCu		
–	42.0	–[6]	18.6	161.2	Re	M	V	–[6]	–	G	G	1075[7]	–	2M	R	1	100	WE	1.25	5	–	65	2	Ad	2050	232
24.6	44.0	–[6]	18.1	161.2	Re	M	V	–[6]	–	G	G	1075[7]	–	3M	R	1	100	WE	1.25	5	90	60	2	Ad	1250	150
52.9	14.9	DB	6.4	107.8	Re	M	D,Hy	M	D,Hy	P	C	10.4	1980	2M	Hy	1	80	WE	0.5	5	–	50	2	–	1560	205
50.4	18.5	DB	–	141.6	Re	M	V	M	D,Hy	P	C	12.3	2350	3M	R	1[9]	66	GE	0.75	5	68	55	2	AdD	1686	176
–	–	–	–	–	Re	M	D,V	M	D,V	O	O	18.0	–	2M	Hy	1[9]	48	WE	–	–	–	–	–	–	1845	134
–	–	–	–	–	Re	M	D,V	M	D,V	O	O	–	–	–	Hy	1	75	AC	0.75	–	–	–	–	–	–	–
–	14.4	DB	1.4	71.5	Re	M	Hy	M	Hy	P,G	C,G	11.7	1900	2M	Hy	1[9]	44	WE	0.75	5	75	35	2	Ad	880	88
8.3	25.0	DB	0	25.3	Tu	Mp	V	Mp	V	G,O	G,O	1000[7]	–	3M	R	1	16.5	EL	0.75	4	60	14	2	Ad	480	49.5
17.3	17.3	DB	0	41.2	Re	Mp	V	Mp	D	P,G	C,G	12.1	2200	3M	R	1[9]	22	BB	0.75	4	72	20	2	Ad	451	44
8.1	27.5	–[6]	–	–	Re	Mp	V	–[6]	–	G,O	G,O	1100[7]	–	3M	R	1	16.5	WE	1.25	4	–	14	2	Ad	345	33
8.1	27.5	–[6]	–	–	Re	Mp	V	–[6]	–	G,O	G,O	1100[7]	–	3M	R	1	16.5	WE	1.25	4	–	14	2	Ad		
8.8	33.9	–[6]	–	31.8	Tu	Mp	S,V	–[6]	–	G,O	G,O	1121[7]	–	2M	R	1[9]	22	GE	1.25	4	24.4	20	2	Adl	465	47
–	18.0	DB	–	–	Re	M	V	M	S,D	P,G	C,G	11.1	1950	2M	R	1	33	EL	0.75	5	75	27.5	2	AdD	335	33
–	–	DB	–	–	–	M	V	M	–	P,G	C,G	10.5	2050	2M	R	1[9]	22	WE	0.75	4	75	18	2	Ad	215	22
–	–	DB	0	11.4	Re	M	D	M	D	O	O	18.5	–	2M,IT	R	1[9]	16.5	WE	1.5	4	25	15	2	Ad	460	39.5
–	–	–	5.2	12.3	Tu	Du	–	Du	D,Hy	SS	C	12.6	2150	IM,IT	Hy	1	22	WE	0.75	–	–	17	2	Ad	–	55.5
–	–	–	5.2	12.3	Tu	Du	–	Du	D,Hy	SS	C	12.6	2150	IM,IT	Hy	1	22	WE	0.75	–	–	17	2	Ad		
–	18.8	DB	0	28.8	Tu	Mp	V	Mp	D	G,O[22]	G,O[22]	950[7]	–	IM,IT	R	1[9]	16.5	AC	0.75	4	30	11	2	–	330	32
8.7	30.8	DB	0	23.1	Re	M	V	–	–	G,O	G,O	1020[7]	–	2M	R	1[9]	25	WE	1.0	4	Con	18	2	AsAd	575	58
61.6	13.1	DB	0	156.4	Re	M	S,V,Hy	M	S,D,Hy	P	L	7.1	2050	2M	S,Hy	1[9]	66	CP	0.5	5	157	50	2	Ad	1200	132
61.6	13.1	DB	0	156.4	Re	M	S,V,Hy	M	S,D,Hy	P	L	7.1	2050	2M	S,Hy	1[9]	66	CP	0.5	5	157	50	2	Ad		
11.7	23.8	–	10.1	12.3	Tu	M	D	M	Hy	SS	C,G	11.2	2100	2M	R	1[9]	22	GE	0.75	4	75	18	1	–	435	45
17.5	16.7	DB	–	36.3	Pl	Mp	V	Mp	D	P	C	12.1	2238	2M,IT,IDu	–	1	22	AC	0.75	4	–	20	2	Ad	260	42
10.3	19.7	–	3.5	15.4	Tu	Mp	V	Mp	V	SS	C[26]	8.2	–	2M	R	1[9]	16.5	GE	0.75	4	45	13	2	AnAd	345	36.4
6.7	32.0	DB	0	9.5	Re	M	Hy	M	Hy	O	O	18.1	–	2M	Hy	1[9]	16.5	GE	1.0	4	30	17	2	CNi	295	26.5
–	50	–	4.4	0	–	M,T	V	M,Du	D	SS,TG	C	–	–	M,T	R	1	6	GE	1.0	2	15	8	2	Ad	170	11.5
13.6	20.8	DB	0	31.1	Tu	M	V,Hy	M	V,Hy	P	C	9.5	1900	M,Du	–	1	20	CP	0.75	3	Con	21	2	–	670	60
5.0	–	–[6]	–	–	Re	M	V	–[6]	–	O,G	O,G	1070[7]	–	2M	R	1	12.7	GE	0.75	3	30	13	2	Br	600	36.1
6.5	25.5	–	2.2	11.2	Re	M	V	M	D,Hy	TG,SS	C	11.6	2035	2M	R	1[9]	12.7	EL	0.75	4	70	13	2	AdD	345	27.5
4.7	27.3	–	2.7	7.7	Tu	Mp	D	Mp	D	TG,SS	C,G	11.1	2055	2M	R	1	9.4	GE	1.0	3	90	10	2	Ad	280	22.5
3.2	23.5	–	6.6	0	–	M	D	M	D	TG	C	11.6	2100	2M	–	1	6.3	GE	1.25	3	52	7	2	Ad	72	6.3
–	–	–	–	–	–	Mp	V	Mp	V	TG,SS	C,G	11.3	2000	2M	R	1	9.4	–	1.0	2	20	10	2	Ad	–	19.4
–	–	–	–	–	Tu	M	D	Mp	D	TG,SS	C,G	10.0	1950	2M	R	1	9.4	–	–	3	65	9	2	Ad	202	17.3
6.9	–	–	–	–	Tu	M,T	D	M,T	D	TG,SS	C	11.4	2050	–	–	–	–	–	–	–	–	–	–	–	–	–
5.4	30.0	–[6]	–	8.3	Re	Mp	V	–[6]	–	O,G	O,G	1000[7]	–	2M	R	1	11	EL	1.0	3	20	12	2	AsAd	240	21.4
3.9	26.0	–	3.7	–	–	Mp	V	Mp	D	TG,SS	C,G	11.1	2055	2M	R	1	7.5	EL	1.5	2	100	8	2	AdD	220	16.8
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	12.5	WE	1.75	1	30	12	–	Ad	180	12
8.2	30.0	–[6]	–	19.6	Tu	Mp	V	–[6]	–	G	G	975[7]	–	3M,IT	R	1	11.5	EL	1.0	3	20	12	2	AsAd	400	28
6.9	28.8	–	3.1	11.7	Tu	MT	D	Du	D	TG,SS	C	11.4	2100	2M	R	1	7.5	GE	1.0	2	–	11	2	–	292	21.5
2.2	36.9	–[6]	–	3.7	Tu	Mp	S,V	–[6]	–	O,G	O,G	982[7]	–	M	R	1	5	GE	0.75	3	17	4	3	Br	113	10

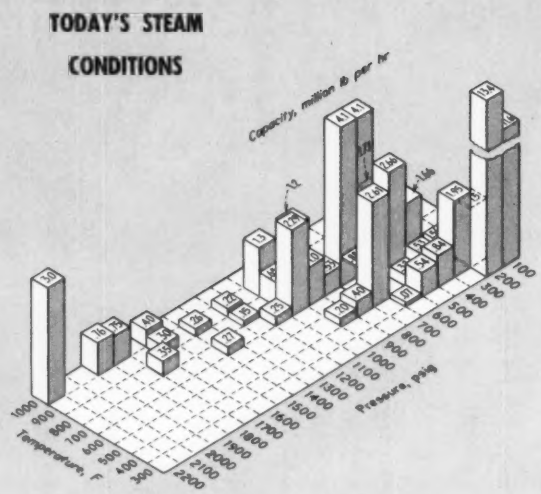
Pl – Plate
R – Regulator
Re – Regenerative
RS – Riley Stoker Corp
S – Speed control
SiB – Silicon Bronze
SP – Springfield Boiler Co
SS – Spreader stoker
ST – Slag tap
T – Turbine drive
TG – Traveling grate stoker
Tu – Tubular

UF – Underfeed stoker
UI – Union Iron Works
V – Vane control
WE – Westinghouse Electric Corp
Wi – Wickes Boiler Co
(823) – Stoker grate area, sq ft

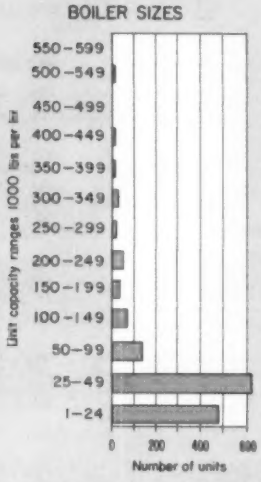
1 – Revised data, previously listed 9-56
2 – Once-through boiler
3 – Double reheat
4 – Hp 3600 rpm, lp 1800 rpm
5 – Preferred standard
6 – Pressurized furnace
7 – Btu per cu ft
8 – Two, driven by main unit shaft
9 – Outdoor installation
10 – Half capacity
11 – Hp 3600 rpm, lp 3600 rpm
12 – Units 1 and 2 listed under Appalachian Electric Power Co
13 – Heating plant
14 – Btu per sq ft per hr
15 – 1800 rpm
16 – Each one-third capacity
17 – Driven by generator shaft
18 – Semi-outdoors
19 – Revised data, previously listed 9-55
20 – Nameplate rating
21 – Replaces 25-cycle unit
22 – Future coal
23 – Fluid coke
24 – Automatic extraction on one point
25 – Normally serves adjacent refinery
26 – Sub-bituminous
27 – Gas turbine exhaust supplies boiler air
28 – Jointly owned with California Electric Power Co
29 – Semi-bituminous



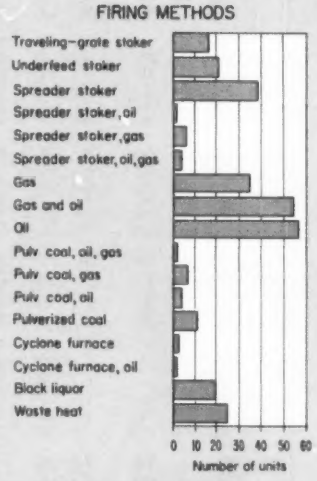
TOTAL REPORTED SALES of both low, high-pressure boilers show gain. H-p unit rise is marked, l-p units keep big lead



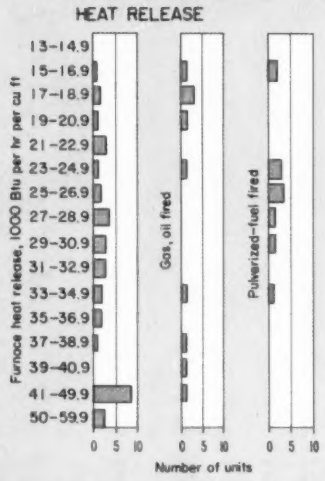
TOTAL CAPACITY increase in high-pressure high-temperature range is due to relatively few but significant installations



SMALL BOILERS continue to fill bulk of industrial heat, process steam needs



OIL, GAS AND OIL, used in most small units, set pace. Black liquor use rises

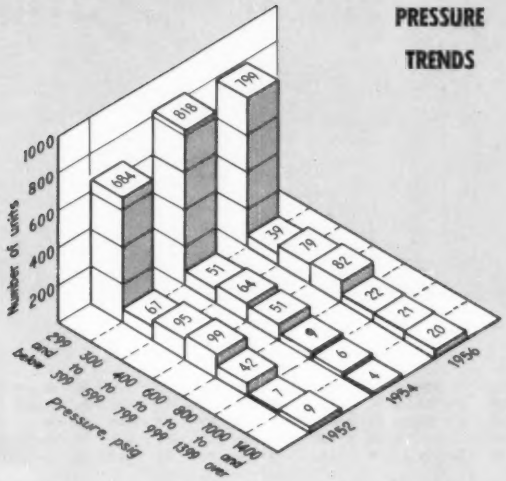


GAS, OIL FIRING also lead in heat release rates. Others vary from low to high

INDUSTRIAL PLANT capacity grows

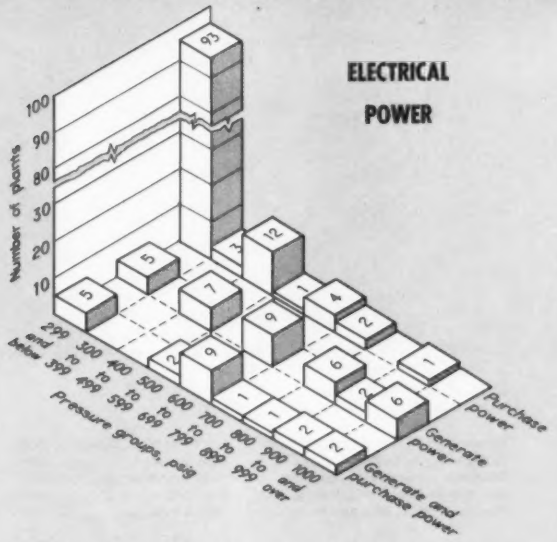
- Three 1-million-lb-per-hr units head new installations
- Packaged boilers give big lift to oil and gas firing
- Black liquor recovery and waste heat units show gain
- Control boards monitored by closed-circuit TV are on rise
- Larger turbines, more auto-extraction condensing units in use

PRESSURE TRENDS



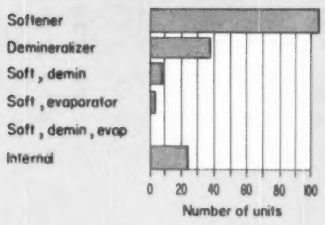
BI-ANNUAL TREND reflects a fairly constant level of new boiler units in all pressure ranges except 1000 psi and above

ELECTRICAL POWER

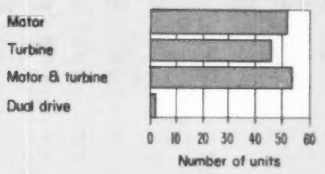


PURCHASED POWER holds wide margin over self-generation and dual schemes. Steam need is main factor in influencing setup

FEED TREATMENT

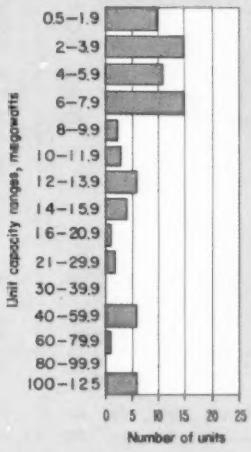


FEED PUMP DRIVES



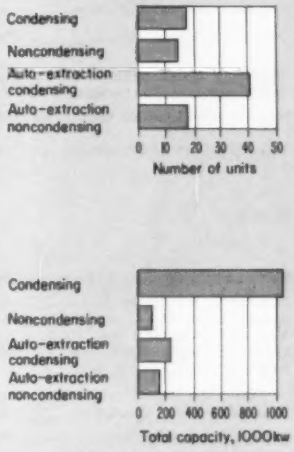
DEMINERALIZERS gain on softeners for water treatment. Dual-drive pumps lag

TURBINE SIZES



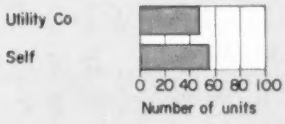
LARGER TURBINES, up to 8 mw, show reverse in former trend to smaller units

TURBINE TYPES

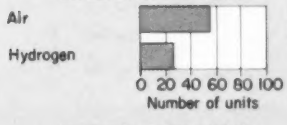


AUTO-EXTRACTION cond machines head total units. Straight cond give most kws

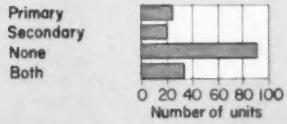
PRIMARY SUBSTATION OWNERSHIP



GENERATOR COOLING

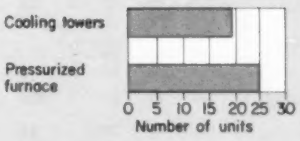


NEUTRAL GROUNDING

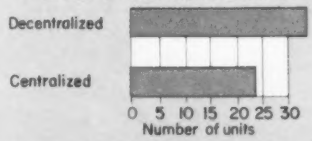


SELF-OWNED SUBS, air cooling trends remain. Grounded neutrals in minority

PLANT FEATURES

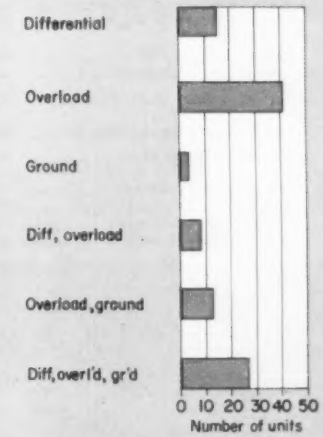


BOILER-TURBINE CONTROLS



COOLING TOWERS show big increase. Control schemes still favor decentralized

SWITCHGEAR RELAY PROTECTION



OVERLOAD RELAYS continue to be major choice as one of plants' safety features

1957 Design Survey: Typical Industrial,

Compiled by R. C. Bellas, Assistant Editor

Company & Location	Consulting Engineers	First operation, new units	Operating steam pressure, psig	Operating steam temperature, F	BOILERS: Number	BOILERS: Capacity, each, 1000 lb per hr	BOILERS: Manufacturer	BOILERS: Boiler & WW surface, 1000 sq ft	BOILERS: Superheater surface, 1000 sq ft	Furnace volume, 1000 cu ft	Heat release, 1000 btu per cu ft per hr	Economizer surface per boiler, 1000 sq ft	Air-heater surface per boiler, 1000 sq ft	Air-heater type	Dust-collector type	Firing
800 TO 1850 PSI																
Aluminum Co. of America, Warrick Country, Indiana	Ebasco Services Inc. (Agents)	8-58	1850	1000	3	1000.0	BW	17.0	68.0	85.2	54.0	13.7	–	Re	Me	C
St. Joseph Lead Co., Joseph Town, Monaca, Pa.	Kaiser Engineers	1-58	1850	1000	2	375.0	CE	7.8	27.8	24.8	20.2	15.3	63.4	Re	E, Me	C
Aluminum Co. of America, Evansville, Indiana	Ebasco Services Inc.	10-57	1800	1000	3	1000.0	BW	17.1	79.2	85.2	15.9	13.7	204.0	Re	Me	C
Utah Copper Div. of Kennecott Corp, Magna, Utah	Kuljian Corp.	1-60	1525	1000	1	600.0	CE	7.0	40.7	46.5	17.8	13.2	151.5	Re	Me	C
Rhinelander Paper Co., Rhinelander, Wis.	Pfiefer & Shultz	6-58	1500	950	1	250.0	BW	5.0	–	9.8	29.5	4.5	72.9	Tu	–	C
Dow Chemical Co, Freeport, Texas, Plant B	Bechtel Corp.	1-58	1300	950	5	500.0	RS	19.2	16.2	22.6	30.5	8.2	51.5	Tu	–	G
Dow Chemical Co, Louisiana Div., Baton Rouge, La.	Bechtel Corp.	1958	1300	950	2	500.0	RS	21.3	18.9	26.6	30.3	9.5	57.5	Tu	None	G
Republic Steel Corp., Cleveland District	United Engineers & Construc. Inc.	5-57	961	850	1	220.0	BW	24.4	–	18.3	18.5	–	52.0	Tu	Me	G, B, BF, CO
Ingersoll-Rand Co., Phillipsburg, N.J.	Gilbert Associates, Inc.	1958	950	640	2	75.0	CE	–	–	–	–	–	–	–	Me	An, O
American Cyanamid Co., Bound Brook, N.J.	Ebasco Services Inc.	10-57	900	825	1	215.0	BW	13.2	13.9	6.9	40.0	.94	62.5	Re	El	C
University of Illinois, Champaign, Ill.	Sargent & Lundy	–	875	760	1	150.0	BW	11.0	3.0	–	25.6	5.9	9.15	Tu	Me	C
St. Croix Paper Co, Woodland, Wash. County, Maine	Charles T. Main, Inc.	9-57	875	900	1	125.0	BW	8.3	4.8	3.5	43.0	–	20.4	Re	None	C
American Maize Products Co., Roby, Indiana	Sargent & Lundy	1957	875	710	1	125.0	CE	15.9	1.8	9.1	–	–	18.4	Tu	Me	C
The Mead Corp. Chillicothe, Ohio	Mead Corp. Eng. Dept.	4-55	875	835	1	250.0	CE	30.2	–	18.6	17.2	–	55.8	Re	Me	C
		7-57	875	850	1	176.0	CE	25.2	4.4	22.4	–	7.5	11.0	SC	E	BL
Kalamazoo Vegetable Parchment Co, Parchment, Mich.		9-57	860	825	1	200.0	CE	21.2	6.0	15.8	15.3	–	31.7	Re	Me	C
Kaiser Aluminum & Chem. Corp, Grammercy, La.	Kaiser Engineers	10-57	850	900	3	350.0	RS	28.6	11.1	16.8	26.7	–	51.5	Re	–	G
Boston Naval Shipyard, Boston 29, Mass.	Charles T. Main Inc.	–	850	825	2	150.0	1-RS	18.3	–	10.2	17.7	–	25.5	Re	Me	C, O
Aluminum Co. of America, Point Comfort, Tex.	Ebasco Services Inc.	5-58	850	825	18	12.9	1-Wi	14.5	–	9.4	–	–	27.7	Tu	–	–
					2	2.00	BW									
					6	19.5										
600 TO 799 PSI																
The Youngstown Sheet & Tube Co, E. Chicago, Ind.	Peth & Rinni	7-57	825	760	2	300	BW	31.1	6.2	22.5	18.9	7.5	45.2	Tu	Me	C, O, G, CB
Oxford Paper Co., Rumford, Maine	Charles T. Main Inc.	–	750	–	–	–	–	–	–	–	–	–	–	–	–	–
Norton Co., Worcester, Mass.	K. R. Warrington	12-58	696	750	1	150	RS	16.9	2.8	10.0	20.0	–	21.3	Tu	Me	C, O, G
American Cyanamid Co., Fortier Plant		1-58	650	750	1	200	EC	21.3	2.5	9.0	30.0	0	24.0	Tu	–	G
Standard Oil Co. (Ind.) Mandan, N.D.	Stearns-Roger Co., Denver, Colo.	4-56	650	750	3	150	BW	11.2	2.3	6.3	33.0	0	1-14.8	Re	None	O
Monsanto Chemical Co., Texas City, Texas		4-58	650	750	3	87.5	CE	–	–	–	–	–	–	Re	–	G
Johns Manville Prod. Corp., Manville, N.J.	Stone & Webster Eng. Co.	12-57	650	650	1	125.0	BW	–	–	–	–	–	–	Re	Me	C, O
Ormet Corp. Burnside, La.	R. R. Popham	1958	650	750	3	117.0	CE	–	–	–	48.4	–	–	Tu	–	O, G
Gulf States Paper Corp, Demopolis, Ala.	H.K. Ferguson Co.	8-57	650	750	2	200.0	BW	15.6	–	10.7	–	–	–	Tu	Me	C, O, G
The Pacific Lumber Co., Soctia, California	Fluor Corp. Ltd.	9-58	650	750	1	125.0	BW	14.7	2.2	7.7	28.8	–	28.2	Tu	Me	SS
El Paso Natural Gas Co., Blanco Plant		10-56	625	600	2	75.0	Vo	8.7	–	–	–	–	–	–	–	G
Dryden Paper Co. Ltd., Dryden, Ontario		11-57	625	725	1	150.0	BW	15.0	–	7.5	26.1	1.2	20.5	Tu	Me	SS
National Petro-Chem. Corp, Tuscolna, Illinois	J.F. Pritchard & Co.	3-56	625	750	1	200.0	CE	23.7	–	15.8	–	–	25.5	Tu	Me	C, G
Columbus Southern Chem. Corp. Lake Charles, La.	Stone & Webster	8-57	620	750	1	175.0	BW	12.0	–	5.4	45.0	–	17.5	Tu	–	G
Thilmany Pulp & Paper Co., Kaukauna, Wis.	Pfeifer and Shultz	1957	620	700	1	155.0	BW	11.7	–	5.5	34.9	–	36.2	Tu	–	C
Transco Gas Pipe Line Corp, Billingsley, Ala.	Transco	12-56	605	750	1	65.0	CE	–	–	–	–	–	–	Tu	None	G
S.D. Warren Co., Cumberland Mills, Me.	Sumner Sellliff Co.	11-58	600	725	1	100.0	CE	8.9	2.0	4.2	30.0	–	5.0	Tu	Me	SS
Buckeye Cellulose Corp. Foley, Fla.	Sargent & Lundy	10-58	600	750	1	285.0	BW	50.6	10.5	53.3	–	6.9	21.3	Tu	–	BL
Gaspesia Sulphite Co, Chandler, Que.		8-58	600	710	1	180.0	CE	10.0	–	–	–	–	19.0	Tu	–	O, B
Crown Zellerbach Corp, Antioch, Calif.	Crown Zellerbach Central Eng.Off.	9-56	600	825	1	300.0	BW	18.8	1.0	15.0	27.0	–	18.0	Tu	–	O
Coosa River Newsprint Co, Coosa Pines, Ala.	Rust Engineering Co.	7-57	600	720	1	70.0	CE	8.3	–	3.4	34.0	1.5	6.0	Tu	Me	SS
H.J. Heinz Co, Pittsburgh, Pa.	Peter Loftus Corp.	12-57	600	750	5	40.0	BW	4.6	1.3	2.0	26.0	2.6	–	–	–	TG
Elk Falls Co. Ltd. Duncan Bay, B.C.,	H.A. Simons	8-56	600	675	1	216.5	BW	27.3	5.4	31.7	–	6.5	236.7	Tu	E	BL
Agricultural & Mechanical College of Texas	H. E. Bovay	11-57	600	750	1	100.0	Vo	–	–	5.0	28.6	–	–	Re	–	OG
P.H. Glatfelter Co, Spring Grove, Pa.	H.M. Wilson Co.	8-56	600	650	1	250.0	CE	29.0	–	18.5	17.6	–	32.0	Re	Me	C
St. Mary's Kraft Corp., St. Mary's, Ga.		1-55	600	750	1	300.0	BW	23.0	–	–	–	–	–	Tu	–	O

AC – Allis Chalmers Mfg. Co.
Ad – Admiralty
ADI – Inhibited Admiralty
AE – Automatic Extraction
Al – Aluminum
AlBr – Aluminum Brass
An – Anthracite
As – Asbarel
AsCu – Arsenical Copper
B – Bark
Bag – Bagasse
BB – Brown Boveri Corp.
BF – Blast furnace gas
BL – Black Liquor
Br – Brass
BW – Babcock & Wilcox Co.
BWG – Babcock-Wilcox & Goldie-McCulloch Ltd.
C – Coal, bituminous
CB – Coke breeze
CE – Combustion Engineering Inc.
CEL – Combustion Engineering-Superheater Ltd.
CO – Coke oven gas
Co – Condensing
CuNi – Copper nickel
Cy – Cyclone firing
D – Damper control
De – Demineralizer
Di – Differential
Dr – Dry type
Du – Dual drive
E – Electrostatic
EC – Erie City Iron Works
El – Elliott Co.
EM – Electric Machinery Mfg. Co.
Ev – Evaporator
FW – Foster Wheeler Corp.
G – Gas
GE – General Electric Co.
GP – Generates own power
Gr – Ground

Institutional Plants, Above 200 psi

FUEL			F-D FANS		I-D FANS				FEED PUMPS		TURBINES					CONDENSER			ELECTRICAL POWER								
Type	Heating value, 1000 Btu per lb	Ash-softening temperature, F	Drive	Air volume control	Drive	Gas-volume control	Water treatment	Ash handling	Drive	Flow control	Capacity, each, 1000 kw	Manufacturer	Backpressure, psia	No. of bleed or auto-extraction pts.	Type	Surface, 1000 sq ft	No. water passes	Tube material	Source	Generator nameplate voltage, kv	Plant distribution voltage, kv	Transformer type	Switchgear relay protection	Neutral grounding	Total boiler capacity incl new units, 1000 lb per hr	Total generator capacity incl new units, 1000 kw
C	10.7	1950	M	D	M	D	De	–	M	R	125	GE	15	6	Co	75	2	Al	GP	–	–	–	–	–	3000	–
C	13.5	2250	M	D,V	M	D,V	De	Pn	2T	S	53	WE	1.5	5	Co	35	2	Adi	GP	14.4	13.8	O	Di,Ov	P	800	106
C	10.7	–	M	V	M	V	De,Ev	Pn, Hy	M	R	125	GE	2	6	Co	75	2	Al	GP	15	–	O	Di	Pr,Se	3000	–
C,G	13.4	2160	M	V	M	Hy	So,Ev	Hy	M	R	75	GE	1	6	Co	58	2	Ad	GP	13.8	4.4	O	Ov	Pr	1650	175
C	13	2100	M	V	–	–	De	Hy	MT	R	7.5	WE	14.5	2	AE,NC	–	–	–	GP	12.5	12.5	Dr	All[1]	–	650	–
G	1.0[2]	–	M	V	M	V	De	–	M	R	2-50 1-40	GE	2-1.0 1-45	2-2 1-1	2-AE,Co 1-AE,NC	1-37.5 1-50	2	Al,Br	GP,PP	14.4	14.4	O	All[1]	Pr,Se	2500	150
G	–	–	M	V	M	D	De	–	M	R	50	GE	1.25	2	Co,AE	30	1	Ad	GP,PP	14.4	–	O	All[1]	Pr	–	–
C, G, BF, CO	–	1900	Du	V	T	SV	So	Pn	MT	R	15	AC	2.50	–	NC	–	–	–	GP,PP	11.5	11.5	O	Di, Ov	Pr	1500	–
An,O	10.8	–	M	V	M	D	So	Pn	T	R,S	–	–	–	–	–	–	–	–	PP	–	4.1	O	All[1]	Pr	240	–
C	13.5	2400	M	D	–	–	So	Hy	M	R	7.5	WE	125	–	NC	–	–	–	–	13.8	–	As	Ov	–	–	20.7
C	11.6	–	M	–	M	Hy	De	Pn	2M	R	7.5	GE	1	2	AE,Co	9	2	As,Ad	GP	13.8	4.16	O,Dr	Di,Ov	Pr	400	22.5
C	11.8	1990	M	D,V	–	–	–	Hy	M	R	12.5	AC	.05	4	Co	8.5	2	Adi	GP	13.8	13.8	–	All[1]	–	575	–
C	10.8	–	M	V	M	Hy	So	Pn	MT	R	5	GE	20	1	AE,NC	–	–	–	GP	2.4	2.4,0.48	O	Di	Pr,Se	451.5	15.5
C	11	2000	M	DV	Du	S,D,Hy	So	Pn, Hy	T	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
BL	6	1600	M	V	–	S	So	Hy	T	S	15.6	GE	50	1	AE,NC	–	–	–	GP,PP	13.8	13.8,4.16	As	Di	Pr	1000	–
C	12.4	2200	M	V	M	D	So	Pn	M	R	9.3	GE	1	1	AE,Co	6.5	2	Ad	GP	4.8	4.8	O	All[1]	–	690	2.37
G	–	–	M	V	–	–	–	–	–	S	15.6	GE	1	3	Co	12	2	Cu-Ni	GP	–	–	–	–	–	1050	31.2
C,O	14.3	2500	M	V	M	–	So	Pn	MT	R	4-5 1-7.5	EI	4-1.7 1-20.4	4 1	AE,Co NC	–	2	Ad,Cu-Ni	PP,GP	13.8,2.4	2.4	O,Dr,As	Dr,Ov	Pr,Se	600	–
WH G WH	–	–	M	V	M	Hy	–	–	4M,4T	R	12.5	GE	50	2	AE	–	–	–	GP	7.2	6.9	As	All[1]	–	750	37.5
C, O, G CB	10.5	–	T	S,D	T	S,D	So	Pn,Hy	1M,2T	R	25	1 WE 1 GE	–	–	AE,Co	30	2	Ad	PP,GP	11	2.3, 0.44	O	Ov, Gr	Pr, Se	1300	–
–	–	–	–	–	–	–	–	–	–	–	10	WE	0.5	1	AE,Co	9	2	Ad	GP,PP	11.5	11.5	–	Di	–	620	24.2
C, O, G	–	–	M	S,D,V	M	S,D	–	Pn	M	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	1.0[2]	–	T	V	T	–	So	–	2M,1T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	800	–
O	–	–	T	DV	T	D	So	–	MT	R	2.5	WE	165	–	NC	–	–	–	GP	4.16	–	O,Dr	All[1]	Pr,Se	450	5
G	1.0[2]	–	T	D	–	–	De	–	T	S		–	–	–	–	–	–	–	PP	–	4.16	O	Di,Ov	Pr,Se	1555	–
C,O	13.5	2200	M	V	M	D	De	Hy	M	R	–	–	–	–	–	–	–	–	PP,GP	4.16	4.16 0.46	O	Di, Gr	–	570	–
O, G	–	–	T	S	–	–	De	–	2M,1T	R	4	EI	–	1	AE,NC	–	2	Ad	GP	4.16	–	–	All[1]	Pr	351	–
C,O,G, B	–	2700	M	V	MT	D	De	ME	2M,1T	S	9.3	GE	1	2	AE,Co	7.5	2	Ad	GP	4.16	4.16	O	All[1]	Pr,Se	370	9.3
W	4.3	–	T	V	T	D	So	–	T	SR	7.5	GE	1	1	AE	5.7	1	As,Cu	GP	2.4, 4.16	2.4	–	All[1]	–	500	2.2
G	1.3[3]	–	–	–	T	D	Ev	–	M	R	1.5	EI	250	–	NC	–	–	–	GP	4.16	–	O	Ov	–	300	3
G,L,B	–	–	M	V	M	Hy	So	Pn	M	R	6.6	BB	50	–	AE	–	–	–	PP,GP	–	–	O	Ov	–	485	–
C,G	11.2	–	M	V	M	V	–	Pn	M	R	–	–	–	–	–	–	–	–	GP	2.4	0.44-0.22	–	–	–	–	12
G	1.0[3]	–	M	V	M	D	–	–	M	R	20.	GE	–	1	NC	–	–	–	GP,PP	13.8	13.8	O	Di,Ov	–	1575	90
C	12.5	–	T	V	–	–	So	Hy	T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	1.0[3]	–	M	D	M	D	De	–	4M,3T	R	–	WE	13	–	Co	5	–	–	GP	0.48	–	Dr	Ov	–	204	–
O,B	–	–	M	V	M	Hy	–	Hy	1M,3T	S	3.7,4.5	EI	40,150	–	NC	–	–	–	PP,GP	11	11	O	Ov	–	–	–
–	3.3	–	M	V	T	S	–	–	–	–	10	GE	65	–	NC	–	–	–	–	12.47	12.47	As	Di	Pr	1000	25
O, B	18.5	–	M	V	M	D,Hy	So	Pn	T	R	6,4	BB,WE	14	–	AE,Co	–	–	–	GP	6.9, 0.55	–	O	–	–	240	–
O	18	–	M	DV	–	–	So	–	MT	R	12.5	GE	1	–	AE,Co	15	2	Al,Br	PP, GP	13.8	11.5	O	All[1]	Pr,Se	300	12.5
B	4.6	–	M	V	T	S	So	ME	M	R	–	–	–	–	–	–	–	–	PP,GP	2.4, 4.16	2.4 4.16	Dr	All[1]	Pr	340	6
C	12	2250	M	D	M	D	So	Pn	T	S	3	WE	130	–	–	–	–	–	–	–	–	–	–	–	–	–
BL	6	–	T	V	T	SV	So	–	1M,1T	R	–	Wo	65	–	NC	–	–	–	PP,GP	0.6	13	O	All[1]	–	456.5	40
O,G	18.5	–	M	D	M	D	–	–	–	R	5	EM	1.5	1	–	–	–	–	–	–	–	–	–	–	300	9.7
C	13.5	2200	M	V	MT	SD	So	Pn	T	SR	–	–	–	–	–	–	–	–	PP,GP	2.3, 0.6	2.3, 0.6	O	All[1]	–	500	–
O	18	–	M	D	M	D	So	–	3M,3T	R	15,6.2,3	GE	1	–	AE,Co	12	2	Ad	GP	13.8,2.4	13.8,2.4	O	All[1]	Pr,Se	750	24.2

Hy – Hydraulic
JI – John Inglis Co. Ltd.
K – E Keeler Co.
L – Lignite
M – Motor drive
MC – Magnetic Coupling
Me – Mechanical
NC – Non Condensing
O – Oil
Ov – Overload
Pn – Pneumatic
PP – Purchased power
Pr – Primary
R – Regulator
Re – Regenerative
RS – Riley Stoker Corp
S – Speed control
SC – Steam coil
Se – Secondary
So – Softener
SS – Spreader stoker
T – Turbine drive
TG – Traveling grate stoker
Tu – Tubular
UI – Union Iron Works
V – Vane control
Vo – Henry Vogt Machine Co.
W – Wood
WE – Westinghouse Electric Corp.
WH – Wasie heat
Wi – Wickes Boiler Co.
Wo – Worthington Corp.
1 – All types, Di, Ov, Gr
2 – Kva
3 – 1000 Btu per cu ft

1957 Design Survey: Typical Industrial,

Compiled by R. C. Bellas, Assistant Editor

Company & Location	Consulting Engineers	First operation, new units	Operating steam pressure, psig	Operating steam temperature, F	BOILERS: Number	BOILERS: Capacity, each, 1000 lb per hr	BOILERS: Manufacturer	BOILERS: Boiler & WW surface, 1000 sq ft	BOILERS: Superheater surface, 1000 sq ft	Furnace volume, 1000 cu ft	Heat release, 1000 Btu per cu ft per hr	Economizer surface per boiler, 1000 sq ft	Air-heater surface per boiler, 1000 sq ft	Air-heater type	Dust-collector type	Firing
400 TO 599 PSI																
Scott Paper Co., Mobile, Ala.	Chas. T. Main Inc.	6-57	575	725	1	139.0	BW	26.0	4.9	20.0	–	–	6.5	Tu	E	BL
Alton Box Board Co., Alton, Illinois	Warren & Van Praag Inc.	12-58	500	750	1	300.0	RS	34.0	–	26.8	–	–	61.0	Tu	Me	C, G, O
Toms River-Cincinnati Chem. Corp., Toms River, N.J.	A. M. Kinney, Inc.	8-59	500	650	1	150.0	CE	14.9	–	9.7	21.3	8.5	–	–	Me	SS
Hudson Pulp & Paper Co., Palatka, Florida	J. E. Sirrine & Co.	11-56	460	725	1	126.8	BW	26.8	4.7	14.5	15.7	3.3	–	–	–	BL
Keystone Steel & Wire Co., Bartonville, Ill.	Keystone	2-58	450	750	4	150.0	CE	13.0	2.3	7.7	–	–	–	–	Me	SS
Great Lakes Paper Co. Ltd., Fort William, Ontario	E & B Cowan	11-57	450	650	1	200.0	CEL	17.0	1.8	10.5	24.8	–	63.0	Tu	–	C
Great Northern Oil Co., St. Paul, Minnesota	H. E. Bovay	12-57	425	750	1	65.0	Vo	7.0	0.8	2.6	–	–	4.6	Tu	–	O, G
Armco Steel Corp, Middletown, Ohio		–	425	750	1	125.0	BW	17.7	3.0	7.8	24.6	–	26.8	Tu	–	BF
Provincial Mental Hospital, Essondale, B.C.	Swanson Wright & Co. Eng. Ltd.	12-57	400	750	1	7.5	BWG	9.9	–	4.0	23.7	–	8.2	Tu	Me	TG
Crown Zellerbach Corp., Camas, Wash.		2-57	400	700	1	162.0	BW	34.0	5.3	24.	12.6	4.6	11.4	Tu	E	BL
Cal. & Hawaiian Sugar Ref. Corp, Crockett, Calif.	Bechtel Corp.	1-58	400	700	2	250.0	BW	17.8	–	11.9	29.0	–	37.9	Tu	–	O, G
El Paso Natural Gas Co., Wingate Gasoline Plant		10-56	400	–	1	30.0	Vo	4.4	–	–	–	–	–	–	–	G
Interlake Iron Corp., Federal Furnace Plant, S.Chicago	Vern E. Alden Co.	6-57	400	650	3	115.0	BW	15.5	–	8.7	21.8	–	–	T	Me	BF, CB O, CO
Great Northern Oil Co., Pine Bend, Minnesota	Purvin & Gertz, Texas	9-55	400	700	4	40.0	UI	4.0	.8	–	–	–	–	Tu	–	O, G
Great Northern Oil Co., Pine Bend, Minnesota	H. E. Bovay	8-56	400	700	1	60.0	Vo	.9	–	2.6	–	–	4.6	Tu	–	O, G
Willard Municipal Light & Water Plant	Fred N. Straus	12-55	400	750	1	45.0	EC	8.1	–	–	–	–	–	–	Me	SS
Norwich State Hosp., Norwich, Conn.	Hubbard Lawless & Blakley	1-58	400	640	1	55.0	CE	7.3	–	–	–	–	–	Re	–	O
Kerr Addison Gold Mines Ltd., Virginiatown, Ont.		4-55	400	440	1	16.0	CE	7.2	–	1.9	–	–	–	Me	–	WH
Socony Mobil Oil Co., East Chicago, Ind.		3-56	400	560	1	60.0	FW	5.8	–	2.6	31.3	–	–	–	–	O, G
Hiram Walker & Sons Ltd., Walkerville, Ontario		12-55	400	600	1	70.0	BWG	8.7	–	3.7	24.7	–	8.1	Tu	Me	C
Standard Oil Co. of B.C., North Burnaby, B.C.	Bechtel Corp. & Stanl. Oil of Calif.	11-55	400	SAT.	1	42.0	CE	4.4	–	–	–	–	–	–	–	O, G
Canadian Forest Prod. Ltd., Port Mellon, B.C.	Sandwell & Co. Ltd.	6-56	400	725	1	77.0	CE	14.2	4.2	6.3	34.8	4.4	4.3	Tu	E	BL
200 TO 399 PSI																
Georgia-Pacific Paper Co., Toledo, Oregon	Sandwell & Co. Ltd.	12-57	350	SAT.	–	150.0	CE	13.5	–	–	–	–	–	Re	–	O
St. Lawrence Corp. Ltd. Red Rock, Ont.	H. A. Simons Ltd.	12-57	300	550	1	156.0	CE	30.4	2.2	17.2	–	8.1	10.9	SC	–	BL
The Givaudan Corp., Delawanna, N.J.	Burns & Roe, Inc.	–	300	–	1	35.0	Wi	–	–	–	–	–	–	–	–	O
U.S. Air Force Base, Whittier, Alaska		–	277	700	4	40.0	EC	4.8	0.6	–	–	–	0.27	Tu	–	O
General Electric,Co. Hickory, North Carolina	Robert & Co. Associates	1-56	275	415	2	35.0	CE	3.3	–	–	48.0	–	–	–	Me	O, G
Naugatuck Chem. Div. Naugatuck, Conn.	U. S. Rubber	11-57	265	SAT.	1	150.0	RS	18.5	–	9.8	17.9	–	12.6	Tu	Me	C
Canadian Forest Products, Pacific Veneer Div., New Westminster, B.C.		6-57	250	SAT.	1	85.0	BW	8.7	–	–	–	–	–	Tu	Me	SS
Weston Paper & Mfg. Co., Terre Haute, Ind.	Rust Engineering Co.	5-57	250	500	1	120.0	BW	13.7	0.49	9.1	–	–	–	–	–	–
General Electric Co. Wire & Cable Div. Lowell, Mass.		6-57	250	SAT.	1	13.0	K	–	–	–	–	–	–	–	–	O, G
Coastal Chem. Corp., Pascagoula, Miss.	Titlestad Corp.	–	250	SAT.	1	65.0	–	–	–	–	–	–	–	–	–	WH
Timberland Lumber Co., New Westminister, B.C.	Swanson Wright & Co. Eng. Ltd.	1-57	250	SAT.	1	56.0	BWG	6.9	–	3.0	29.0	–	5.7	Tu	Me	W
Western Kraft Corp., Albany, Oregon	Sandwell, Inc.	3-57	250	580	1	75.0	BW	15.3	–	–	–	–	–	Tu	Me	BL
Western Kraft Corp. Albany, Oregon	Sandwell, Inc.	10-55	250	406	1	57.0	BW	12.7	–	–	–	–	–	Tu	Me	BL
McColl-Frontenac Oil Co. Ltd., Montreal, P.Q.		11-56	250	500	1	100.0	BW	16.7	–	5.6	22.8	–	–	–	–	O, G
Firestone Tire & Rubber Co. Pottstown, Pa.	Day & Zimmerman	3-58	240	SAT.	1	100.0	BW	1.9	–	5.5	22.2	–	21.7	Tu	Me	CO
University of Houston, Houston, Texas	Lockwood, Andrews, & Newman	6-58	235	400	3	29.0	CE	6.8	–	0.75	50.0	–	–	–	–	G
Visking Co, Terre Haute, Indiana		3-57	235	SAT.	1	28.0	BW	3.2	–	–	–	–	–	–	–	O, G
Exchange Park Co., Dallas, Texas	Lane Gamble & Associates	–	235	SAT.	2	50.0	BW	5.3	–	1.4	47.3	–	–	–	–	G
B.C. Correctional Institution, Haney, B.C.	Swanson Wright & Co. Eng. Ltd.	7-57	235	SAT.	2	–	JI	3.5	–	1.0	27.5	–	–	–	–	O
Ethyl Corp, Houston, Texas		–	225	SAT.	1	85.0	BW	7.7	–	3.2	36.7	–	–	–	–	G
White Washburne Corp, Hinsdale, N.H.	Zack C. Hinds	10-57	225	450	1	28.0	BW	3.3	–	0.9	38.0	–	–	–	–	O
Kimberly-Clark Corp., New Milford, Conn.	Skidmore, Owings & Merrill	12-57	225	SAT.	1	65.0	BW	6.0	–	3.0	24.4	2.3	–	–	Me	SS
B.F. Goodrich Chem. Co. Avon Lane, Ohio	Dalton & Dalton	11-57	220	440	1	80.0	RS	10.3	3.0	3.7	28.9	–	–	–	Me	TG

AC – Allis Chalmers Mfg. Co.
Ad – Admiralty
Adl – Inhibited Admiralty
AE – Automatic Extraction
Al – Aluminum
AlBr – Aluminum Brass
An – Anthracite
As – Askarel

AsCu – Arsenical Copper
B – Bark
Bag – Bagasse
BB – Brown Boveri Corp.
BF – Blast furnace gas
BL – Black Liquor
Br – Brass
BW – Babcock & Wilcox Co.

BWG – Babcock-Wilcox & Goldie-McCulloch Ltd.
C – Coal, bituminous
CB – Coke breeze
CE – Combustion Engineering Inc.
CEL – Combustion Engineering-Superheater Ltd.
CO – Coke oven gas
Co – Condensing
CuNi – Copper nickel

Cy – Cyclone firing
D – Damper Control
De – Demineralizer
Di – Differential
Dr – Dry type
Du – Dual drive
E – Electrostatic
EC – Erie City Iron Works

El – Elliott Co.
EM – Electric Machinery Mfg. Co.
Ev – Evaporator
FW – Foster Wheeler Corp.
G – Gas
GE – General Electric Co.
GP – Generates own power
Gr – Ground

Institutional Plants, Above 200 psi

FUEL			F-D FANS		I-D FANS				FEED PUMPS		TURBINES					CONDENSER			ELECTRICAL POWER								
Type	Heating value, 1000 btu per lb	Ash-softening temperature, F	Drive	Air-volume control	Drive	Gas-volume control	Water treatment	Ash handling	Drive	Flow control	Capacity, each, 1000 kw	Manufacturer	Backpressure, psia	No. of bleed or auto-extraction pts	Type	Surface, 1000 sq ft	No. water passes	Tube material	Source	Generator nameplate voltage, kv	Plant distribution voltage, kv	Transformer type	Switchgear relay protection	Neutral grounding	Total boiler capacity incl new units, 1000 lb per hr	Total generator capacity incl new units, 1000 kw
BL	6.5	–	M	V	M	D	So	–	–	–	–	–	–	–	–	–	–	–	PP,GP	2.4	2.3	–	–	–	565	12
C,G,O	10	1850	M	V	M	D	So	Hy	M	Hy	11.5	GE	14	–	AE,Co	13	2	–	PP,GP	13.8	13.8	O,As	Di,Gr	Se	600	22
C,O	13	2200	Du	SV	Du	SD	–	Pn	3M,2T, 1Du	SR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
BL	3.4	–	M	–	T	S	So	–	M,T,Du	SR	2-7.5 1-6	GE WE	14	–	2-AE,Co 1-AE,NC	7.5	2	Ad	GP	4.16	4.16	–	–	–	628	26.2
C	10.5	–	Du	D	Du	D	So	Hy	MT	R	1.25[2] 2-7.5 1-15[2]	GE	50	1	2-Co 2-AE	–	2	Ad	GP	6.6	6.6	O,As	All[1]	Pr,Se	600	37.5
C	12	–	1-M,1-Du	D	1-M,1-Du	D,Hy	–	Pn	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O, G	1.0[3]	–	T	D	T	D	De	–	1-M,1-T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	260	–
BF	–	–	T	SD	T	D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C	11.9	2260	Du	S,Hy	T	S	–	–	1-M,1-T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
BL	3.2	–	M	V	M	Hy	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O,G	17.9,1.0[3]	–	M	DV	T	D	So	–	3-T	R	5	WE	25	–	AE,Co	1.5	1	Al,Br	GP	4.16	4.16	–	All[1]	Pr	500	10
G	1.0[3]	–	–	–	T	D	Ev	–	T	R	1.5	EI	100	–	NC	–	–	–	GP	–	–	O	Ov	–	70	1.5
BF,CB O, CO	–	–	Me,Du	SD	Du	SD	So	ME	4-T	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	505	–
O, G	18.6,1.1[3]	–	T	D	–	D	De	–	1-M 2-T	R	–	–	–	–	–	–	–	–	PP	–	–	O	Ov	–	220	–
O, G	16.6,1.1[3]	–	T	D	T	D	De	–	1-M 2-T	R	–	–	–	–	–	–	–	–	PP	–	–	O	Ov	–	220	–
C	13	2400	M	MC	M	D	De,So	Pn	1-M 1-T	R	2.5	GE	1	–	Co	–	2	–	GP	2.4,4.16	2.4	O	Ov	Pr,Se	90	–
O	–	–	T	D	T	D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
WH	–	–	–	–	–	M	–	So	–	1-M 1-T	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O,G	18.5,1.9[3]	–	T	S	–	S	So	–	2-T	S	–	–	–	–	–	–	–	–	PP	–	2.3	O	Di	–	–	–
C	14	2600	M	V	M	D	So	Pn	1-M 1-T	S	2.5	GE	35	–	NC	–	–	–	GP	4.16	0.44	–	Di	Pr,Se	200	4
O, G	18,1.3[3]	–	T	DV	–	D	–	–	T	S	–	–	–	–	–	–	–	–	PP	–	–	O	Ov	–	102	–
BL	6.3	–	M	D	M	Hy	–	–	1-M 1-T	R	1.5,3	WE	50	–	AE	–	2	–	GP	3.7,1.8	2.3	O	Ov,Gr	–	235	5
O	18	–	M	V	–	–	So	–	1-M 1-T	R	–	–	–	–	–	–	–	–	PP	–	13.8	O,Dr	All[1]	Se	350	–
BL	6	–	M	–	T	Hy	So	–	1-M 1-T	SR	–	–	–	–	–	–	–	–	PP	–	–	–	–	–	600	–
O	18.6		MT	D	T	S	–	–	T	–	–	–	–	–	–	–	–	–	PP	–	.24	O,As	Ov	–	100	–
O	19	–	MT	SV	MT	SV	–	–	2-M 2-T	R	2-2 1-2.5	Wo EI	0.75	1	AE,Co	1.3	2	Ad	GP	2.4	–	O,Dr	Ov	–	120	6.5
O,G	–	–	M	V	–	–	–	–	2-M 1-T	R	–	–	–	–	–	–	–	–	PP	–	13.8	O	Ov	Se	70	–
C	12.9	2000	T	SD	T	–	–	Hy	2-M 1-Du	R	–	–	–	–	–	–	–	–	PP	–	0.55	–	–	–	350	–
W, O	5.5	–	M	V	Du	V	–	–	1-M 1-T	R	–	–	–	–	–	–	–	–	PP	–	0.44	O	Ov	–	176	–
C	10.3	1960	M	V	M	D	So	Pn	2-T	R	2.5	GE	–	–	AE,Co	–	2	Br	GP,PP	0.44	0.44	O	Ov	–	120	2.5
O, G	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
WH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	PP	–	4.16	O	Ov,Gr	Pr,Se	–	–
W	–	–	M	V	M	D	–	Pn	1-M 1-T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	56	–
BL	6.5	–	M	D	T	S	–	–	1-M 1-T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
BL	6.5	–	M	D	T	S	–	–	1-M 1-T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O, G	18.8,1.4[3]	–	Du	D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CO	–	–	Du	D	Du	D	So	Pn	1-M 1-T	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	1.5[3]	–	MT	D	Du	D	So	–	1-M 2-T	R	–	–	–	–	–	–	–	–	PP	–	–	O	Ov	Pr,Se	87	–
O, G	–	–	M	D	–	–	So	–	M	R	–	–	–	–	–	–	–	–	PP	–	4.16	O	Ov	Pr	43	–
G	1.0[3]	–	–	D	M	–	De,S	–	2-M 2-T	R	–	–	–	–	–	–	–	–	PP	–	0.48 0.27	As	Ov	Pr,Se	100	–
O	18.3	–	T	V	T	SD	–	–	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	1.0[3]	–	–	D	T	D	De	–	1-M 2-T	R	–	–	–	–	–	–	–	–	PP	–	13.8	O	All[1]	Se	340	–
O	18	–	M	V	–	D	–	–	1-M 1-T	R	–	–	–	–	–	–	–	–	PP	–	0.48	O	Ov,Gr	–	60	–
C,O	13.1	2200	M	V	T	S	So	Pn	1-M 1-T	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C	12	2000	Du	D	Du	D	So	Pn	Du	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200	–

Hy – Hydraulic
JI – John Inglis Co. Ltd.
K – E Keeler Co.
L – Lignite
M – Motor drive
MC – Magnetic Coupling
Me – Mechanical
NC – Non Condensing
O – Oil
Ov – Overload
Pn – Pneumatic
PP – Purchased power
Pr – Primary
R – Regulator
Re – Regenerative
RS – Riley Stoker Corp.
S – Speed control
SC – Steam coil
Se – Secondary
So – Softener
SS – Spreader stoker
T – Turbine drive
TG – Traveling grate stoker
Tu – Tubular
UI – Union Iron Works
V – Vane control
Ve – Henry Vogt Machine Co.
W – Wood
WE – Westinghouse Electric Corp.
WH – Waste heat
Wi – Wickes Boiler Co.
Wo – Worthington Corp.
1 – All types, Di, Ov, Gr
2 – Kva
3 – 1000 Btu per cu ft

1957 Design Survey: Typical Industrial,

Compiled by R C Bellas, Assistant Editor

Company & Location	Consulting engineers	First operation, new units	Nominal steam pressure, psig	Nominal steam temperature, F	BOILERS: Number	BOILERS: Capacity each 1000 lb per hr	BOILERS: Manufacturer	BOILERS: Firing	Ash handling	TURBINES: Type	TURBINES: Manufacturer	ELECTRICAL POWER: Source	ELECTRICAL POWER: Plant distribution voltage	ELECTRICAL POWER: Transformer	ELECTRICAL POWER: Switchgear relay protection	ELECTRICAL POWER: Neutral grounding	Total boiler capacity including new units, 1000 lb per hr	Total generator capacity including new units, 1000 kw
175 TO 200 PSIG																		
Sicks Breweries Ltd, Lethbridge, Ont.		8-56	200	385	2	25	FWL	O,G	–	–	–	PP	0.22	O	Ov	–	50	–
Hay & Co, Searchmont, Ont.		5-57	200	355	2	25	FW	W	Hy	Co	AC	GP	0.44	O	Ov	–	60	–
Shell Oil Co of Canada Ltd, Shellburn, Vancouver	Swanson Wright & Co. Eng. Ltd.	1-58	200	485	1	60	BWG	O	–	–	–	–	3.31	O	–	–	180	–
Jones & Laughlin Steel Corp, Aliquippa, Pa.	Kuljian Corp	2-57	200	510	1	68	BW	TG	–	–	–	–	–	–	–	–	–	–
Courtaulds Canada Ltd, Cornwall, Ont.		4-57	200	388	1	115	BW	O	–	–	–	–	–	–	–	–	550	–
Convair, Div of Gen'l Dynamics, Palmdale, Cal.		11-56	200	Sat	4	35	K	O	–	–	–	PP	0.48	O,As	Ov	Pr,Se	140	–
Ford Motor Co, Mt. Clemens, Mich.	Austin Co	1-58	185	Sat	2	25	Wi	O,G	–	–	–	PP	0.48	As	–	–	50	–
Chevrolet-St. Louis, St. Louis, Mo.	Boddy, Benjamin & Woodhouse	10-58	180	Sat	1	150	UI	TG,G	Pn	–	–	–	–	–	–	–	–	–
Euclid Div. G.M.C. Hudson, O.		2-58	175	Sat	2	40	CE	O,G	–	–	–	PP	0.48	Dr	All [1]	Se	80	–
N. J. State Prison Farm, Leesburg, N.J.	Philip H. Oppenheimer	–	175	378	2	14	BW	O	–	–	–	PP	–	–	–	–	28	–
Rochester Products Div, G.M.C, Rochester, N.Y.		8-55	175	380	1	60	BW	TG	–	–	–	PP	0.44	O,Dr	Ov,Gr	Se	154	–
International Paper Co		3-57	175	368	1	15	FW	G	–	–	–	–	–	–	–	–	–	–
Newberry State Hospital, Newberry, Mich.	E R Little Associates, Inc.	4-58	175	–	3	42.5	Wi	TG	Pn	NC	Wo	GP	–	O	Ov	–	120	–
Fisher Body Div. G.M.C, Mansfield, O.		11-56	175	377	1 2	60 80	BW	TG	Pn	–	–	PP	13.5	O	Ov	Pr	220	–
151 TO 174 PSIG																		
New Jersey Zinc Co (of Pa.) Gloucester, N. J.	Gilbert Associates, Inc	4-58	170	575	1	100	CE	O	–	–	–	PP	–	–	–	–	190	–
Simpson Paper Co, Everett, Wash.		–	170	–	1 2 1 3	70 42 40 30	BW FW BW BW	O,G,BL	–	NC	GE	PP	–	O	Ov	Se	284	–
Aluminum Co of America, Lafayette, Ind.		3-58	165	–	1	80	BW	TG	Pn	–	–	PP	–	O	–	–	220	–
Ford Motor Co, Highland Park, Mich.	Dravo Corp	4-58	165	Sat	4	50	K	O,G	–	–	–	PP	0.48	O	Ov,Gr	–	200	
Anderson Prichard Oil Corp, Arkansas City, Kan.		2-57	165	375	2	50,75	EC	O,G	–	–	–	–	–	–	–	–	–	–
Dunlop Tire & Rubber Co, Buffalo, N.Y.	Zack C Hinds	11-57	165	504	2	46.5	BW	TG	Me	–	–	PP	2.2	O	–	–	250	–
Mohawk Paper Mills Inc, Cohoes, N.Y.		–	160	375	1	36	K	SS	Me	NC	GE	PP	0.60	O	Ov	Pr,Se	73	–
Mohawk Paper Mills Inc, Waterford, N.Y.		–	160	375	1	35	K	SS	Me	NC	GE	PP	0.60	O	Ov	Pr,Se	70	–
Detroit Bd. of Education, Poe-Edmonson plant	Snyder & McLain	10-57	160	Sat	2	10	K	UF	Me	–	–	PP	0.22	O	–	–	20	–
Westinghouse Elec Corp, Hampton, S.C.		–	160	Sat	1	65	CE	O	–	–	–	PP	4.16	O	Ov	Pr,Se	125	–
126 TO 150 PSIG																		
Thos Lipton Inc, Albion, N.Y.	Zack C Hinds	9-57	150	366	1	25	UI	UF	Me	–	–	PP	–	–	–	–	–	–
Bell Aircraft Corp, Buffalo, N.Y.	Zack C Hinds	1-57	150	366	3	25	WB	O	–	–	–	PP	–	–	–	–	–	–
Aero Products Oper, Allison Div, G.M.C, Vandalia, O.		4-58	150	365	2 1	25 45	BW CE	O,G	–	–	–	PP	0.44	Dr	Ov	–	95	–
University of Idaho, Moscow, Idaho		12-56	150	365	2	16	AI	O,G	–	–	–	PP	2.4	O	Ov	Se	102	–
Miss.-Ohio Oil Terminal Co, East Liverpool, O.		12-56	150	335	1	12.5	CB	O,G	–	–	–	PP	0.22	O	–	–	13.9	–
Caterpillar Tractor Co, Peoria, Ill.	Larramore, Douglass & Popham	–	150	Sat	2	200	Sp	TG,O	Pn	–	–	PP	1.4	As	Ov,Gr	Pr	400	–
Caterpillar Tractor Co, Aurora, Ill.	H K Ferguson	10-57	150	Sat	3	87	Wi	TG	Pn	–	–	PP	13.2	As	Ov,Gr	Pr	261	–
Electro-motive Div, G.M.C, LaGrange, Ill.	Schmidt, Garden & Erikson	10-58	150	416	1	150	BW	TG	Pn	–	–	PP	0.48	Dr	Di	Pr	450	–
Cadillac Div, G.M.C, Plant #1, Detroit, Mich.		–	150	365	4	120	BW	C,G	Pn	–	–	PP	0.44	O	Ov,Gr	Se	480	–
Ohio Ag. Exp. Sta, Wooster, O.	F G Browne & Associates	2-57	150	–	1	15	BW	G	–	–	–	PP	–	–	–	–	–	–
Stromberg-Carlson Div, Gen'l Dynamics, Rochester, N.Y.	Robson-Woese	5-57	150	Sat	1	40	BW	C	Pn	–	–	PP	0.46	–	Ov	Pr,Se	105	–
Babcock & Wilcox Co, Milwaukee, Wis.		10-56	150	Sat	2	30	BW	TG	Pn	–	–	–	–	–	–	–	60	–
Bay State Abrasive Prod. Co, Westboro, Mass.	Kenneth Warrington	–	150	360	1	25	RS	O	–	–	–	PP	–	–	–	–	16	–

[1] Ov,Gr on 2 units

AC – Allis-Chalmers Mfg Co
Ai – Ames Iron Works
As – Askarel
BL – Black Liquor
BW – Babcock & Wilcox Co
BWG – Babcock & Wilcox, Goldie McCullough
C – Coal, bituminous
CB – Cleaver-Brooks Co
CE – Combustion Engineering, Inc.
Co – Condensing
DB – Dominion Bridge Co Ltd
Di – Differential
Dr – Dry type
EC – Erie City Iron Works
FW – Foster Wheeler Corp
FWL – Foster Wheeler Limited
G – Gas
GE – General Electric Co
GP – Generates own power
Gr – Ground
Hy – Hydraulic
JI – John Inglis Co, Ltd
K – E Keeler Co
Me – Mechanical

Institutional Plants, 200 psi and Below

Compiled by R C Bellas, Assistant Editor

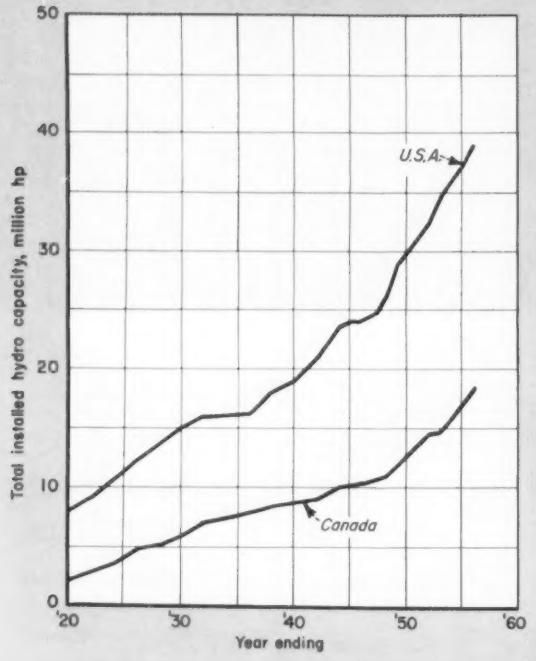
Company & Location	Consulting Engineers	First operation, new units	Nominal steam pressure, psig	Nominal steam temperature, F	BOILERS: Number	BOILERS: Capacity each 1000 lb per hr	BOILERS: Manufacturer	BOILERS: Firing	Ash handling	TURBINES: Type	TURBINES: Manufacturer	ELECTRICAL POWER: Source	ELECTRICAL POWER: Plant distribution voltage	ELECTRICAL POWER: Transformer type	ELECTRICAL POWER: Switchgear relay protection	ELECTRICAL POWER: Neutral Grounding	Total boiler capacity including new units, 1000 lb per hr	Total generator capacity including new units, 1000 kw
121 TO 125 PSIG																		
Cadillac Div. GMC, Plant #4, Detroit, Mich.		–	125	353	3	40	BW	O,G	–	–	–	PP	0.44	O	Ov	Se	120	–
Ford Motor Co, Lorain, Ohio	H. A. Kuljian & Co	11-57	125	350	3	80	EC	TG	Pn	–	–	PP	–	–	–	–	–	–
Ford Motor Co, Novi, Mich.	Black & Veatch	10-56	125	350	3	80	EC	TG	Pn	–	–	PP	–	–	–	–	240	–
Ford Motor Co, Lima, Ohio	Black & Veatch	7-56	125	353	3	45	UI	TG	–	–	–	PP	–	–	–	–	135	–
Marchant Calculators, Inc, Oakland, Cal.		9-57	125	–	2	10	CB	O,G	–	–	–	PP	0.48	O	Ov,Gr	–	–	–
Northspan Uranium Mines, Ltd, Panel mine		7-57	125	353	3	20	FWL	SS	Pn	–	–	PP,GP	2.2	O,Dr	Di, Ov	–	60	–
U.S.N.A.A.S. Whiting Field, Milton, Fla.		–	125	–	1	27	FW	O	–	–	–	PP	–	–	–	–	100	–
Cornwall Canning Co, Ltd, Div. of MacDonalds Consol. Ltd.	P. H. Halden	7-57	125	353	2	15	JI	G	–	–	–	PP	0.23	O	Ov	Pr	33	–
Duffy Mott Co, Clapps Baby Food Div, Williamson, N.Y.		6-56	125	344	1	35	K	O	–	–	–	PP	0.22	Dr	–	–	50	–
Moosehead Breweries Ltd, Lancaster, B.C.		–	125	Sat	2	10	FW	O	–	–	–	PP	0.55	–	–	–	20	–
Norfolk General Hospital, Norfolk, Va.	Watson & Hart	10-57	125	Sat	2	30	K	O	–	–	–	PP	0.20	O	Ov	Se	60	–
Metropolitan State Hospital, Norwalk, Cal.		–	125	Sat	3 1	10,17 27	EC BW	OG	–	–	–	PP	2.46	O	–	Se	–	–
The Mengel Co, Laurel, Miss		1-57	125	Sat	1	24	BW	G,W	–	–	–	PP	0.44	O	–	–	60	–
Richmond State Hospital, Richmond, Ind.		1-58	125	320	3	35	Vo	UF	Pn	–	–	PP	–	–	–	–	105	–
Allegheny Co. Workhouse, Blawnox, Pa.	Rockwell	4-57	125	345	3	12	TI	TG	–	–	–	GP	–	–	–	–	60	–
Clark Grave Vault Co, Columbus, O.		12-56	125	–	1	36	BW	SS	Me	–	–	PP	0.44	O	Ov,Gr	Se	53	–
The Visking Corp, London, Tenn.	Barber & McMurry	1-57	125	Sat	2	34.5	CE	TG	Pn	–	–	–	–	–	–	–	34.5	–
Catholic University of America, Washington, D.C.		–	125	345	4	20	TI	O	–	–	–	PP	–	O	Ov	Pr,Se	80	–
Ranier State School, Buckley, Wash.	David Hopkins & Assocs	–	125	–	1 1 1	22 18 35	Wi EC EC	TG, SS	Pn	–	–	PP	0.20	O,Dr	Ov	Se	75	–
Winnebago State Hospital, Winnebago, Wis.	Wis. Bu. Engineering	–	125	353	3	15	UI	UF	Pn	–	–	PP	0.20	O,Dr	Ov,Gr	Pr,Se	60	–
F. C. Huyck & Sons, Aliceville, Ala.	J. A. Evans	7-56	125	–	2	11	BW	OG	–	–	–	PP	0.44	O	Ov	Pr,Se	22	–
101 TO 120 PSIG																		
McClellan A.F.Base, Cal.		–	120	–	2	20	–	OG	–	–	–	PP	–	–	–	–	40	–
Pronto Uranium Mines, Ltd, Algoma Mills, Ont.		9-57	120	350	1	20.1	JI	UF	Me	–	–	PP	2.3	O	Ov	–	40	–
N. J. State Sanatorium, Glen Gardner, N. J.	P. H. Oppenheimer	10-57	115	347	1	19	BW	O	–	–	–	PP	–	–	–	–	44	–
Enterprise Foundry Co, Ltd, Sackville, N. J.		1-57	115	–	1	15	DB	UF	–	–	–	–	–	–	–	–	–	–
Addressograph-Multigraph Corp, Cleveland, O.	H. K. Ferguson Co	1-57	115	Sat	2	60	BW	TG	Pn	–	–	PP	–	O	Gr	–	140	–
H. K. Porter, Henry Disston Div, Phila, Pa.		6-57	110	–	2	20	CB	O	–	–	–	–	–	–	–	–	–	–
Speer Carbon Co, St. Marys, Pa.		4-57	105	340	2	10	BW	UF	Me	–	–	PP	0.22	O	Ov	–	–	–
100 PSIG																		
Algom Uranium Mining Co, Ltd, Nordic Steam & Comp. Plant, Ont.		–	100	325	3	22	FW	UF	Me	–	–	GP,PP	2.3	O	Di	Pr	66	–
Algom Uranium Mining Co, Ltd, Quire Steam & Comp. Plant, Ont.		–	100	325	3	22	FW	UF	–	–	–	GP,PP	2.3	O	Di	Pr	66	–
Offutt Air Force Base, Neb.		–	100	330	3	20.5	Ti	O,G	–	Co	Wo	GP,PP	13.5	O	All [1]	Pr,Se	61.5	–
American Hardware, Clarksdale, Miss.		–	100	Sat	2	10	BW	G	–	–	–	PP	4.16	O	–	Pr,Se	–	–
Danly Mach. Spec, Inc, Cicero, Ill.	Nieler, Rich & Bladen	12-56	100	–	3	25	CE	O	–	–	–	PP	0.48	O	Ov	–	–	–
Pittsburgh Plate Glass Co, Shelbyville, Ind.	B. T. Fowler	9-57	100	–	2	10	AI	G	–	–	–	–	–	–	–	–	–	–
U.S. Veterans Hospital, Boise, Ind.		11-57	100	337	3	9	K	UF	Pn	–	–	–	–	–	–	–	25	–
Illinois Inst. of Tech, Chicago, Ill.	Sargent & Lundy	11-57	100	Sat	1	60	BW	C	Pn	–	–	–	–	–	–	–	120	–
LaCie De Publication De La Presse, Ltée, Montreal		1-59	100	Sat	2	10	DB	O	–	–	–	PP	0.55	O	Ov	Pr	–	–
Michigan Chemical, Eldorado, Ark.		1-57	100	Sat	1	15	UC	G	–	–	–	–	–	–	–	–	15	–

NC – Non-condensing
O – Oil
Ov – Overload
Pn – Pneumatic
PP – Purchased power

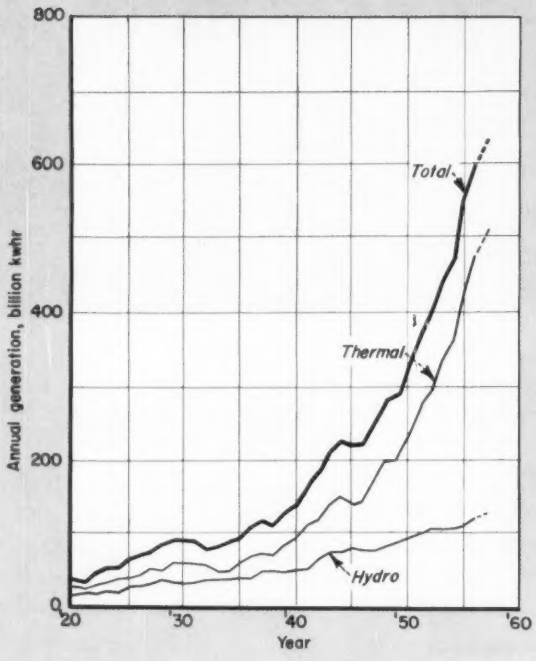
Pr – Primary
RS – Riley Stoker Corp
Se – Secondary
Sp – Springfield Boiler Co
SS – Spreader stoker

TG – Traveling grate stoker
Ti – Titusville Iron Works Co
UF – Underfeed Stoker
UI – Union Iron Works
Vo – Henry Vogt Machine Co

W – Wood
WB – William Bros Boiler & Mfg Co
Wi – Wickes Boiler Co
Wo – Worthington Corp
1 – All types, Di, Ov, Gr



HYDRO CAPACITY continues long-term upsurging trend in both U.S. and Canada; includes central station, industrial



CENTRAL STATION generation in U.S. plants keeps pace with country's economic growth, shows no sign of slackening

Future U. S. hydro development

The tables on the following pages show that water-power construction in the U.S. has slackened in the east and midwest but has picked up markedly in the mountain and Pacific coast states.

In the 37 states east of the Rocky Mountains, 35 projects were developed or completed in 1956. These have an ultimate capacity of less than 4,000,000 hp and include 1,280,000 hp being installed in the U.S. section of the St. Lawrence River project.

In the 11 mountain and Pacific coast states, 52 projects were built or completed during 1956 with an ultimate capacity of over 14,000,000 hp. About 12,000,000 hp, in 41 projects, are in the three Pacific coast states. We believe this trend will continue because east of the Rocky Mountains a major part of our desirable hydro sites have already been developed. Only the St. Lawrence River and Niagara Falls offer opportunity for future large installations. On-schedule construction of the international section of the St. Lawrence project will allow the 2,480,000-hp plant to start operating late next year.

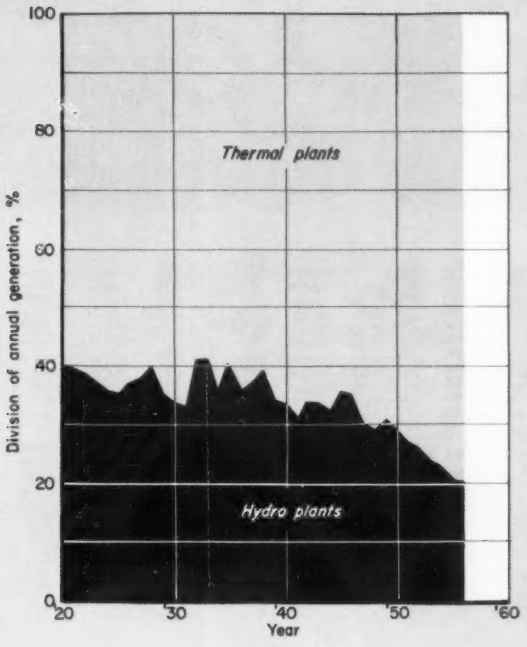
Hydro Plants. In August, 1957, Congress approved construction of the $600,000,000 Niagara project by the Power Authority of the State of New York. Starting work has been delayed, however, until objections against the water conduit, reservoir and loss of taxes are settled. These factors delay issuing a permanent license by the Federal Power Commission.

The project includes a power house at Lewiston with thirteen 200,000-hp 300-ft-head francis turbines, and a pumped-storage plant with twleve 28,000-hp pump turbines. Combined capacity of the two plants will total 2,936,000 hp; almost equal to the 3,102,000 hp of Grand Coulee, world's largest operating power plant.

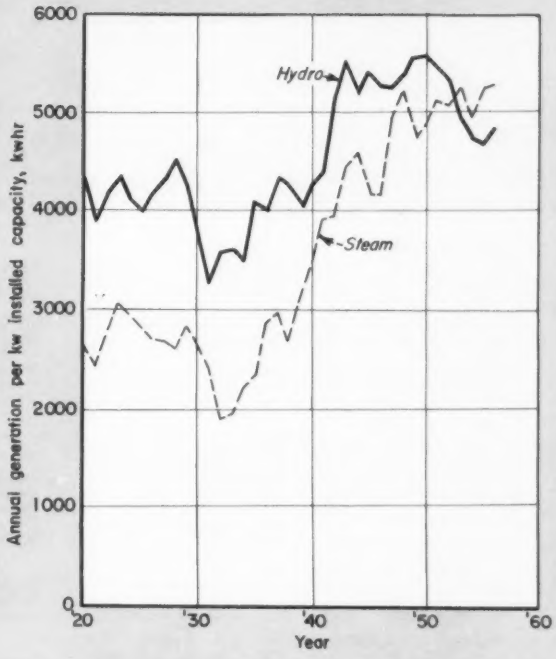
Largest turbines on order are the five 233,600-hp 371-ft head units ordered by the Pacific Northwest Power Co. for its Pleasant Valley plant on the Snake River. Controversy involving public power and other interested groups still holds up construction of this plant.

Long-term Trends. Power generation in U.S. central stations just topped 600 billion kwhr in 1956, chart above, right. Hydro plants supplied 122 billion of this total, about 21%. Because of the faster rate of growth of the steam plants, hydro's share of annual energy output has dropped from 40% in 1935 to 20% in 1956. Contrasting with this shrinking percentage share, hydro capacity increased from 16,000,000 to 39,000,000 hp—more than doubling.

Despite stepped-up construction schedules of private utilities, hydro expansion continues to be dominated by local, state and Federal government agencies. In the last 25 years U.S. Army Engineers, the Bureau of Reclamation, and the Tennessee Valley Authority have built or scheduled



HYDRO GENERATION in U.S. utility systems, though growing steadily, supplies a rapidly diminishing share of total



CAPACITY USE of U.S. central stations shows downward trend for hydro-power units while steam-plant units climb

concentrates in west coast area

for construction 107 plants with an ultimate capacity of 28,500,000 hp, see tables on following pages. But the Federal Government's hydro construction program has undoubtedly passed its peak. Other agencies are doing the job, even in the west coast area.

Future Hydro. The Federal Power Commission estimates the capacity of undeveloped hydro sites at about 87 million kw with an annual generation of about 360 billion kwhr. About 54% of the undeveloped capacity stands west of the Continental Divide. When we move the dividing line to the Mississippi River, we find 71% of this capacity to the west. The Columbia River basin has 34% of the national total. It is our largest potential.

About 29,000,000 kw of the undeveloped sites are either under construction, planning or survey, or are covered by preliminary permits issued by the FPC. When these sites have been developed about half of all sites in the U.S. will be in use.

Canada. Hydro developments in Canada continue to boom with 845,000 hp going into operation in 1956. Of 18,500,000-hp total installed capacity, 87% stands in central stations. About 95% of the 78-billion kwhr generated in Canada's central stations last year were produced by hydro.

Like the U.S., Canada will probably accelerate its steam-plant program in the next decade. After putting the St. Lawrence project into operation, Ontario will have developed practically all of her desirable sites. A large steam-plant program now under way, will meet the demands of future load growth. One of these plants will rank, in capacity, with the world's largest.

In Quebec, Aluminum Company of Canada started construction on its one-million-hp Chute des Passes project. This will have five 200,000-hp 540-ft head turbines in an underground plant, giving Canada the world's three largest underground hydro plants: Kemano in British Columbia with 2.4 million hp, Bersemis Lac Casse with 1.2 million hp and Chute des Passes with one million hp.

Construction has also started on the third section of Beauharnois on the St. Lawrence River. Eleven 73,700-hp fixed-blade propeller turbines for 81-ft head will be installed. Total capacity of this plant will then be 2,200,000 hp and leave only one site on the St. Lawrence to be developed—Lachine at Montreal.

Future hydro developments promise big things in Canada. Field surveys of the Hamilton River in Labrador confirm that about 6 million hp can be developed near Hamilton Falls. Basic designs for the power plant have been completed and reports are favorable for transmitting the energy to industrial sites at tidewater.

A project on the Peace River in Northern British Columbia will have an 8-million-hp installation, largest in the world, with a storage reservoir 260-miles long up the Peace River Canyon.

1957 Design Survey: Typical Hydroelectric

Compiled by F A Annett, Contributing Editor

Company or government agency	Design or consulting engineers	Project name	[1] New or redeveloped	River	State	Project started, date	[2] Dam type	Crest length, ft	Max height, ft	[3] Type of installation
NEW ENGLAND STATES										
Central Maine Power Co	Central Maine Power Co	Bar Mills	Red.	Saco	Me.	1955				I
St Croix Paper Co	Chas T Main, Inc	Woodland	Red.	St Croix	Me.	1954				I
Bangor Hydro-Electric Co	Bangor Hydro-Electric Co	Milford No. 3A	Red.	Penobscot	Me.	1955	CG	960	30	I
Northern Chemical Industries			New		Me.	1955				I
Connecticut River Power Co	Chas T Main, Inc; N E Power Service Co	Samuel O Moore	New	Connecticut	N.H. & Vt.	1952	C&E	3,148	180	I
Citizens Utilities Co	Stone & Webster; Citizens Utilities	Newport No. 11	Red.	Clyde	Vt.	1956	CG	90	19	I
Ryegate Paper Co		East Ryegate	Red.		Vt.	1956				I
Southworth Co		West Springfield	New		Mass.	1955				I
American Writing Paper Corp		Holyoke	Red.		Mass.	1955				I
Parsons Paper Co		Holyoke	Red.		Mass.	1955				I
MIDDLE ATLANTIC STATES										
Port Authority of the State of NY	Uhl, Hall & Rich	Barnhart Island	New	St Lawrence	N.Y.	1954	CG CG	3,200 3,100	172 126	S
Niagara Mohawk Power Corp	Niagara Mohawk Power Corp	Blake Falls	New	Raquette	N.Y.	1954	C&E	600	50	I
Niagara Mohawk Power Corp	Niagara Mohawk Power Corp	Stark	New	Raquette	N.Y.	1955	C&E	235	40	I
Niagara Mohawk Power Corp	Niagara Mohawk Power Corp	Prospect	New	West Canada	N.Y.	1957	CG	270	52	I
Eastman Kodak Co	Company engineering staff	Waste treatment	New	Genesee	N.Y.	1955		10	115	I
New York State Electric & Gas Corp	Company engineering staff	High Falls	New	Saranac	N.Y.	1955	CG	274	58	I
EAST NORTH CENTRAL STATES										
Northern States Power Co of Wis	Pioneer Service & Engineering Co	Menomonie	Red.	Red Cedar	Wis.	1955	CG			S
Nekoosa-Edwards Paper Co		Port Edwards	Red.		Wis.	1956				I
Clark Bros Milling Co		Augusta	Red.		Wis.	1955				I
WEST NORTH CENTRAL STATES										
U.S. Army Engineers	U.S. Army Engrs; Chas T Main, Inc	Garrison	New	Missouri	N.D.	1945	EF	12,000	210	I
U.S. Army Engineers	U.S. Army Engrs; Chas T Main, Inc	Oahe	New	Missouri	S.D.	1948	EF	9,300	242	I
U.S. Army Engineers	U.S. Army Engrs; Harza Engrg Co	Gavins Point	New	Missouri	S.D. & Neb.	1948	EF	8,700	74	I
SOUTH ATLANTIC STATES										
Alexandria Water Co		Alexandria	New		Va.	1956				I
Georgia Power Co	Georgia Power Co; Southern Services, Inc	Oliver Dam	New	Chattahoochee	Ga.	1957	CG	2,020	70	S
U.S. Army Engineers	U.S. Army Engrs; Erik Floor & Assoc	Buford	New	Chattahoochee	Ga.	1950	Earth	1,630	192	I
U.S. Army Engineers	U.S. Army Engrs; Erik Floor & Assoc	Fort Gaines	New	Chattahoochee	Ala. & Ga.	1955	C&E	13,570		I
U.S. Army Engineers	U.S. Army Engineers	Jim Woodruff	New	Apalachicola	Fla.	1947	CG	6,134	106	I
EAST SOUTH CENTRAL STATES										
U.S. Army Engineers	U.S. Army Engineers	Barkley	New	Cumberland	Ky.	1957				I
Tapoco, Inc	Aluminum Company of America	Chilhowee	New	Little Tennessee	Tenn.	1955	EF, RF	1,410	82	I
U.S. Army Engineers	U.S. Army Engrs; Amburser Engr Corp	Old Hickory	New	Cumberland	Tenn.	1951	CG & EF	3,750	98	I
U.S. Army Engineers	U.S. Army Engineers	Cheatham	New	Cumberland	Tenn.	1950	CG	495	75	I
WEST SOUTH CENTRAL STATES										
U.S. Army Engineers	U.S. Army Engrs; Sverdrup & Parcel, Inc	Dardanelle	New	Dardanelle	Ark.	1957	CG			I
U.S. Army Engineers	U.S. Army Engineers	Greers Ferry	New	White	Ark.	1957	CG			I
U.S. Army Engineers	U.S. Army Engineers	Table Rock	New	White	Ark.	1952	CG & EF	6,388	250	I
U.S. Army Engineers	U.S. Army Engrs; Sverdrup & Parcel, Inc	Eufaula	New	Canadian	Okla.	1957	CG & EF			
MOUNTAIN STATES										
Washington Water Power Co	Ebasco Services Inc	Noxon	New	Clark Fork	Mont.	1955	CG & EF	4,700	190	O
Montana Power Co	Bechtel Corp	Cochrane	New	Missouri	Mont.	1956	CG	869	105	S
U.S. Army Engineers	U.S. Army Engrs; Erik Floor & Assoc	Fort Peck No. 2	New	Missouri	Mont.	1957	Earth	21,026	250	I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Glendo	New	North Platte	Wyo.	1954	EF	4,640	207	I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Fremont Canyon	New	North Platte	Wyo.	1956				I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Palisades	New	Snake	Idaho	1952	EF	2,200	206	I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Wanship	New	Weber	Utah	1956				O
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Gateway	New	Weber	Utah	1956				O
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Deer Creek	New	Provo	Utah	1955	EF	1,300	235	I
Garkane Power Association, Inc	Harza Engineering Co	Boulder	New	Boulder Creek	Utah	1957	EF	450	30	I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Glen Canyon	New	Colorado	Ariz.	1957	CA	1,500	700	I
PACIFIC COAST STATES										
U.S. Army Engineers	U.S. Army Engineers	Chief Joseph	New	Columbia	Wash.	1949	CG	2,315	235	I
U.S. Army Engineers	U.S. Army Engineers	McNary	New	Columbia	Wash. & Ore.	1947	CG & EF	8,000	157	I
U.S. Army Engineers	U.S. Army Engineers	The Dalles	New	Columbia	Wash. & Ore.	1951	CG			I
U.S. Army Engineers	U.S. Army Engineers	The Dalles Fishway	New	Columbia	Ore.	1951				I
Public Utility Dist, Grant County	Harza Engineering Co	Priest Rapids	New	Columbia	Wash.	1956	CG & EF	8,412	178	I
Public Utility Dist, Grant County	Harza Engineering Co	Wanapum	New	Columbia	Wash.	1955	CG & EF	9,400	128	I
PUD No. 1, Chelan County	Stone & Webster Engineering Corp	Rocky Reach	New	Columbia	Wash.	1956	CG	2,770	140	I
U.S. Army Engineers	U.S. Army Engrs; Sverdrup & Parcel, Inc	Ice Harbor	New	Snake	Wash.	1956	CG	2,790	100	I
City of Seattle	Dr J L Savage	Ross	New	Skagit	Wash.	1937	CA	1,300	540	I
Tacoma Dept of Public Util, Light Div	Harza Engineering Co	Mayfield	New	Cowlitz	Wash.	1955	A & G	875	245	I
Puget Sound Power & Light Co	Stone & Webster Engineering Corp	Lower Baker No. 3	New	Baker	Wash.	1957				I
Puget Sound Power & Light Co	Stone & Webster Engineering Corp	Upper Baker	New	Baker	Wash.	1956	CG	1,200	300	I
Puget Sound Power & Light Co	Stone & Webster Engineering Corp	Snoqualmie No. 2	New	Snoqualmie	Wash.	1956				I
Pacific Power & Light Co	Bechtel Corp	Swift No. 1	New	Lewis	Wash.	1956	Earth	2,100	512	I
PUD No. 1, Cowlitz County	H Zinder & Assoc; Bechtel Corp	Swift No. 2	New	Lewis	Wash.	1957		18,500	136	I
Pacific Power & Light Co	Ebasco Services Inc	Merwin	New	Lewis	Wash.	1929	Arch	752	314	I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Roza	New	Yakima	Wash.	1956				I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Kennewick	New	Yakima	Wash.	1953	CG	768	8	I
Portland General Electric Co	Ebasco Services Inc	North Fork	New	Clackamas	Ore.	1956	Arch	675	206	O
Portland General Electric Co	Ebasco Services Inc	Pelton	New	Deschutes	Ore.	1956	CA	750	200	O
Portland General Electric Co	Ebasco Services Inc	Faraday	New	Clackamas	Ore.	1956				O
California Oregon Power Co	Pioneer Service & Engineering Co	Lemola No. 2	New	North Umpqua	Ore.	1953	CS & B	195	25	O
California Oregon Power Co	Pioneer Service & Engineering Co	Big Bend	New	Klamath	Ore.	1956	EF	652	72	S
California Oregon Power Co	Pioneer Service & Engineering Co	Eagle Point	New	Canal	Ore.	1956	CG	120	15	I

[1] The term "New" applies to a project on a site not developed before. "Redeveloped" indicates a project on a site that has been developed before and now has new turbines, settings, generators or a new plant.

[2] A&G, arch and gravity; CA, concrete arch; C&E, concrete and earth; CG, concrete gravity; CG&EF, concrete gravity and earth fill; CG, S&B, concrete gravity, slab & buttress, CS&B, concrete slab and buttress; EF, earth fill; EF&RF, earth-faced rock fill; E&RF, earth and rock fill; EF-CW, earth fill with concrete core wall; HF, hydraulic fill; P&G, piers & gates; RF, rock fill; RFCF, rock fill, concrete face; REF, rolled earth fill, SG sector gates; S&R, sluiceways and rock fill; TC timber crib.

[3] I, indoor; S, semi-outdoor; O, outdoor; U, underground.

[4] AC – Allis-Chalmers Mfg Co
AE – American Elin Corp
BB – Brown Boveri Corp
BL – Baldwin Lima-Hamilton Corp
CAC – Canadian Allis-Chalmers Ltd
CBS – Charles Barber & Sons
CGE – Canadian General Electric Co Ltd
CVL – Canadian Vickers Ltd
CWC – Canadian Westinghouse Co Ltd
DEC – Dominion Engineering Co Ltd
EC – Elliott Co
EE – English Electric Co Ltd

Plants in the United States and Canada

Date of initial operation	Initial capacity, hp	Added capacity, No. of units	Date of added capacity	Ultimate capacity, hp	No. of units installed	Hydro-turbine capacity	Hydro-turbine type	Speed, rpm	Static head, ft	Design head, ft	[4] Hydro-turbine manufacturer	[4] Governor manufacturer	Scroll case concrete or steel	Penstock valve, type	Generator capacity, kva	Synchronizing manual or automatic	[5] Thrust-bearing location	Design power factor	Kilovolts	[6] Generator manufacturer
1956	6,000	..	.....	6,000	2	3,000	Propeller	120	20	20	JL	W	Concrete	Head gates	2,500	Automatic	BG	0.80	2.4	WE
1956	4,500	..	.....	4,500	3	1,500	Francis	257	40	40	MS	L	Plate Steel	Head gates	1,000	Manual	HS	0.80	0.48	WE
1956	7,575	1	1956	10,100	4	2,525	Propeller	120	20-8	20	MS	L	Concrete	Head gates	2,000	Semi-auto.	AG	0.80	4.15	GE
1956	780	..	.....	780	1	780	Impulse	831	822	822	MS	.....	Cast Steel	.....	.....	.....	.....	.....	.....	.....
1956	220,000	..	.....	220,000	4	55,000	Francis	128.6	159-119	150	MS	W	Plate Steel	Head gates	39,000	Manual	BG	0.90	13.8	WE
1957	2,400	..	.....	2,400	1	2,400	Francis	400	59-52	57	JL	W	Concrete	Head gates	2,000	Manual	AG	0.80	4.16	GE
1957	438	..	.....	438	1	438	Francis	86	13	13	JL	.....	Concrete	Head gates	Drives mill machinery		.....	.....	.....	.....
1956	200	..	.....	200	1	200	Francis	360	30	30	MS	.....	.....	.....	.....	.....	.....	.....	.....	.....
1956	600	..	.....	600	1	600	Francis	200	28	28	JL	.....	Concrete	Head gates	500	Manual	AG	0.80	0.6	WE
1956	370	..	.....	370	1	370	Francis	180	18	18	JL	.....	Concrete	Head gates	312	Manual	AG	0.80	0.6	EM
1958	1,280,000	..	.....	1,280,000	8	80,000	Propeller	94.7	88-79	81	AC	AC	Concrete	Head gates	60,000	Auto. or Man.	BG	0.95	13.8	GE
					8	80,000	Propeller	94.7	88-79	81	BL	AC	Concrete	Head gates	60,000	Auto. or Man.	BG	0.95	13.8	GE
1957	18,650	..	.....	18,650	1	18,650	Francis	112.5	69	67	MS	W	Plate steel	Head gates	16,000	Automatic	BG	0.90	6.9	AC
1957	32,000	..	.....	32,000	1	32,000	Francis	120	105	104	MS	W	Plate steel	Head gates	25,000	Automatic	BG	0.90	11.5	GE
1959	23,900	..	.....	23,900	1	23,900	Francis	180	137-132	136	JL	W	Plate steel	Head gates	19,250	Automatic	BG	0.90	6.9	GE
1957	686	..	.....	686	1	686	Francis	900	115	115	JL	W	Bronze	Butterfly	690	Automatic	HS	0.90	0.44	EC
1956	8,200	1	1956	20,800	1	8,200	Francis	514	268-258	230	JL	W	Welded pl st	Gate valve	8,750	Semi-auto.	AG	0.80	6.9	EC
1958	7,500	..	.....	7,500	2	3,750	Kaplan	180	33-21	30	MS	W	Concrete	Head gates	3,000	Manual	AG	0.80	4.16	EM
1957	1,700	..	.....	1,700	2	850	Francis	225	16	16	JL	.....	Concrete	Head gates	Connects to existing generator		.....	.....	.....	.....
1956	254	..	.....	254	1	254	Francis	218	22	22	JL	.....	Concrete	Head gates	Drives mill machinery		.....	.....	.....	.....
1955	264,000	1	1956	440,000	5	88,000	Francis	90	187-100	150	BL	W	Plate steel	Head gates	84,210	Manual	BG	0.95	13.8	GE
1961	170,000	..	.....	425,000	2	85,000	Francis	94.7	210-130	170	AC	.....	Plate steel	Head gates	65,000	Manual	BG	0.95	13.8	.....
1956	162,000	2	1957	162,000	3	54,000	Kaplan	75	66-40	48	BL	W	Concrete	Head gates	35,100	Manual	BG	0.95	13.8	GE
1957	1,776	..	.....	1,776	2	888	Francis	450	64	64	JL	.....	Concrete	Head gates	635	Manual	AG	.....	4.16	GE
1959	84,100	..	.....	84,100	3	25,200	Propeller	150	65-68	67	NN	W	Concrete	Head gates	22,500	Automatic	BG	0.80	7.6	WE
					1	8,500	Propeller	257	65-68	67	NN	W	Concrete	Head gates	7,500	Automatic	BG	0.80	7.6	WE
1956	118,400	..	.....	118,400	2	55,000	Francis	100	170-104	136	NN	PB	Plate steel	Head gates	44,444	Manual	BG	0.90	13.8	WE
					1	8,500	Francis	277	170-104	136	JL	PB	Plate steel	Head gates	6,667	Manual	BG	0.90	0.48	WE
1962	182,000	..	.....	182,000	4	45,500	Kaplan	112.5	88-38	70	NN	.....	Concrete	Head gates	36,111	Auto. or Man.	BG	0.90	13.8	.....
1955	42,000	1	1956	42,000	3	14,000	Terry	75	32-14	26	NN	W	Concrete	Head gates	11,111	Manual	BG	0.90	13.8	WE
1962	232,000	..	.....	232,000	4	58,000	Kaplan	65.5	72-18	44	.....	.....	Concrete	Head gates	36,111	.....	BG	0.90	13.8	.....
1957	70,000	..	.....	70,000	3	23,333	Kaplan	128.6	64-50	56.5	NN	W	Concrete	Head gates	19,610	Auto. or Man.	BG	0.85	6.9	WE
1956	180,000	..	.....	180,000	4	45,000	Kaplan	75	60-25	45	BL	W	Concrete	Head gates	31,250	Manual	BG	0.80	13.8	GE
1958	60,000	..	.....	60,000	3	20,000	Kaplan	60	32	32	NN	W	Concrete	Head gates	13,333	Manual	BG	0.90	13.8	WE
1964	167,000	..	.....	167,000	4	41,750	Kaplan	75	55-20	43	.....	.....	Concrete	Head gates	31,579	.....	BG	0.95	13.8	.....
1962	132,600	..	.....	132,600	2	66,300	Francis	120	214-161	175	.....	.....	Plate steel	Head gates	50,526	.....	BG	0.95	13.8	.....
1958	138,000	..	.....	274,000	2	68,000	Francis	128.6	228-134	190	EE	.....	Plate steel	Head gates	52,623	Manual	BG	0.95	13.8	WE
					2	1,000	Francis	600	228-134	190	JL	.....	Plate steel	Head gates	875	Manual	AG	0.80	0.48	WE
1964	138,000	..	.....	138,000	3	46,000	Francis	94.7	112-88	103	.....	.....	Plate steel	Head gates	35,000	.....	BG	0.95	13.8	.....
1959	550,000	..	.....	550,000	4	137,500	Francis	100	162-154	152	AC	AC	Plate steel	Head gates	101,660	Manual	BG	0.95	14.4	GE
1958	84,000	..	.....	84,000	2	42,000	Kaplan	128.6	88-63	80	MS	W	Welded pl st	Head gates	30,000	Automatic	BG	0.80	13.8	WE
1961	110,000	..	.....	110,000	2	55,000	Francis	128.6	210-115	170	AC	.....	Plate steel	Butterfly	42,105	Automatic	BG	0.95	13.8	.....
1961	33,500	..	.....	33,500	2	16,750	Francis	180	133-67	107	MS	.....	Plate steel	Butterfly	13,333	Manual	AG	0.90	6.9	AE
1960	67,000	..	.....	67,000	2	33,500	Francis	257	364-240	300	NN	W	Plate steel	Butterfly	25,263	.....	.....	0.95	11.5	.....
1957	158,000	..	.....	158,000	4	39,500	Francis	163.6	245-114	190	MS	W	Welded pl st	Butterfly	30,000	Manual	AG	0.95	11.5	PO
1958	2,000	..	.....	2,000	1	2,000	Francis	450	142-75	116	JL	W	Cast iron	Butterfly	1,500	Manual	AG	0.95	2.4	EM
1958	5,800	..	.....	5,800	2	2,900	Francis	514	148-145	145	JL	W	Cast iron	Butterfly	2,250	Manual	AG	0.95	2.4	EM
1957	7,000	..	.....	7,000	2	3,500	Francis	360	140-78	120	JL	W	Plate steel	Gate	2,750	Manual	AG	0.90	2.4	EC
1958	3,950	..	.....	5,925	2	1,975	Impulse	900	1,532-1,519	1,527	PB	PB	Cast steel	Slide gates	1,750	Manual	HS	0.90	2.4	EC
	1,244,000	..	.....	1,244,000	8	155,500	Francis	150	563-345	450	.....	.....	Cast steel	Head gates	125,000	.....	.....	0.90	13.8	.....
1965	1,607,000	12	55-57	2,707,000	10	100,000	Francis	100	179-148	165	NN	AC	Plate steel	Head gates	67,386	Manual	BG	0.95	13.8	WE
		2	58		6	100,000	Francis	100	179-148	165	MS	W	Plate steel	Head gates	67,386	Manual	BG	0.95	13.8	WE
					2	3,500	Francis	514	179-148	165	PB	PB	Plate steel	Head gates	3,000	Manual	AG	0.80	4.16	EC
1953	1,565,200	10	53-55	2,333,000	14	111,300	Kaplan	85.7	92-62	80	MS	AC	Concrete	Head gates	73,684	Manual	BG	0.95	12GE;	2EE
		4	1956	.....	2	3,500	Francis	277	92-62	80	PB	W	Concrete	Head gates	3,750	Manual	AG	0.80	4.16	EM
1957	1,779,800	..	.....	2,777,200	14	123,000	Kaplan	85.7	91-60	81	BL	PB	Concrete	Head gates	82,105	Manual	BG	0.95	13.8	GE
					2	18,800	Kaplan	200	91-60	74	AC	PB	Concrete	Head gates	14,200	Manual	BG	0.95	13.8	WE
					2	4,500	Francis	277	91-60	81	PB	W	Service units	.....	3,500	Manual	AG	0.80	4.16	EM
1961	912,000	..	.....	1,824,000	8	114,000	Kaplan	85.7	84-32	78	EE	PB	Concrete	Head gates	83,000	Manual	BG	0.95	13.8	EE
1962	864,000	..	.....	1,728,000	8	108,000	Kaplan	85.7	80-52	75	.....	.....	Concrete	Head gates	75,000	.....	.....	0.95	13.8	.....
1961	980,000	..	.....	1,540,000	7	140,000	Kaplan	90	98-55	92	MS	W	Concrete	Head gates	107,000	.....	BG	0.95	15	WE
1961	429,000	..	.....	858,000	3	143,000	Kaplan	90	105-78	96	MS	.....	Concrete	Head gates	94,737	Auto. or Man.	BG	0.95	13.8	GE
1952	560,000	1	1956	560,000	4	140,000	Francis	150	.....	385	3BL; 1NN	W	Welded pl st	Butterfly	100,000	Auto. or Man.	AG	0.80	13.8	WE
1960	220,000	..	.....	220,000	4	55,000	Francis	138.5	185-135	182	MS	PB	Plate steel	Head gates	45,000	Manual	BG	0.90	13.8	AC
1959	54,000	1	1959	131,000	1	77,000	Francis	163.6	235-200	227	MS	W	Plate steel	Butterfly	61,000	Manual	BG	0.90	13.8	GE
1958	120,000	..	.....	120,000	2	60,000	Francis	200	288-248	275	BL	PB	Plate steel	Head gates	47,200	Automatic	BG	0.90	13.8	GE
1957	10,000	1	1957	38,000	1	28,000	Francis	300	282	272	MS	W	Plate steel	Head gates	22,500	Automatic	AG	0.90	6.9	GE
1958	300,000	..	.....	300,000	3	100,000	Francis	180	397-275	378	MS	W	Welded pl st	Butterfly	75,555	Manual	BG	0.90	13.8	GE
1958	92,000	..	.....	92,000	2	46,000	Francis	128.6	128	128	MS	W	Welded pl st	Head gates	38,889	Auto. or Man.	AG	0.90	13.8	GE
1931	62,650	1	1958	252,400	1	57,500	Francis	120	.....	170	AC	W	Plate steel	Head gates	56,250	Manual	BG	0.80	13.8	GE
1958	18,000	..	.....	18,000	1	18,000	Francis	225	162-140	158	PB	PB	Plate steel	Head gates	11,842	Manual	AG	0.95	6.6	.....
1956	1,400	..	.....	1,400	2	700	Francis	600	63	63	JL	.....	Concrete	Head gates	Drives pumps		.....	.....	.....	.....
1958	69,000	..	.....	69,000	2	34,500	Francis	138.5	135-110	130	NN	.....	Plate steel	Head gates	24,000	Automatic	BG	0.80	13.8	WE
1957	165,000	..	.....	165,000	3	55,000	Francis	138.5	158-150	150	MS	W	Plate steel	Head gates	36,000	Manual	BG	0.90	13.8	GE
1958	25,500	1	1958	60,000	1	34,500	Francis	138.5	132-116	130	NN	W	Plate steel	Head gates	24,000	Manual	BG	0.80	13.8	WE
1956	46,000	..	.....	46,000	1	46,000	Francis	400	727-704	705	AC	W	Welded pl st	Butterfly	34,737	Automatic	AG	0.95	11.5	WE
1958	112,000	..	.....	112,000	2	56,000	Francis	277	463	440	BL	PB	Welded pl st	Butterfly	42,100	Automatic	AG	0.95	11.5	GE
1957	3,900	..	.....	3,900	1	3,900	Francis	720	434	409	JL	W	Cast steel	Gate valve	3,125	Manual	HS	0.90	2.4	WE

EEC – English Electric Co of Canada Ltd
EM – Electric Machinery Mfg Co
GE – General Electric Co
GGG – Gilbert Gilkes & Gordon Ltd
IE – Ideal Electric & Mfg Co
JL – James Leffel & Co
KMW – KMW of Sweden
L – Lombard Governor Co
MS – S Morgan Smith Co
MSC – S Morgan Smith, Canada Ltd
MSI – S Morgan Smith-Inglis Co
MVE – Metropolitan Vickers Electrical Co Ltd
NBP – (Neyrpic) Neyret-Beylier & Piccard Pictet
NN – Newport News Shipbuilding & Dry Dock Co
PO – Pacific Oerlikon Co
PB – Pelton Div, Baldwin-Lima-Hamilton Corp
SEC – Swedish Electric Co
SGE – Swedish General Electric Co
VIW – Vancouver Iron Works Ltd
W – Woodward Governor Co
WE – Westinghouse Electric Corp

[5] AG, indicates thrust bearing is above generator rotor; BG, thrust bearing is below generator rotor, HS, horizontal-shaft machine.

[6] Vertical-shaft 4-jet type.

[7] Vertical-shaft 6-jet type.

1957 Design Survey: Typical Hydroelectric

Compiled by F A Aarett, Contributing Editor

Company or government agency	Design or consulting engineers	Project name	[1] New or redeveloped	River	State	Project started, date	[2] Dam type	Crest length, ft	Max height, ft	[3] Type of installation
PACIFIC COAST STATES, cont.										
U.S. Army Engineers	U.S. Army Engineers	Hills Creek	New	M F Willamette	Ore.	1956	E & RF	.....	.....	I
U.S. Bureau of Reclamation	U.S. Bureau of Reclamation	Green Springs	New	Emigrant Creek	Ore.	1956	.....	.....	.....	O
Idaho Power Co	International Engr Co; J P Growdon; I C Steele; & Harold Stearns	Brownlee	New	Snake	Ore. & Idaho	1955	E & R	1,320	395	O
Idaho Power Co		Oxbow	New	Snake		1955	E & R	1,100	200	O
Pacific Gas & Electric Co	Pacific Gas & Electric Co	Poe	New	Feather	Calif.	1954	CG	430	60	S
Pacific Gas & Electric Co	Pacific Gas & Electric Co	Butt Valley	New	Butt Creek	Calif.	1956	HF	1,250	130	I
Pacific Gas & Electric Co	Pacific Gas & Electric Co	Caribou No. 2	New	Feather	Calif.	1956	Earth	1,370	80	I
Pacific Gas & Electric Co	Pacific Gas & Electric Co	Belden	New	Feather	Calif.	1957	CG	505	150	I
Pacific Gas & Electric Co	Pacific Gas & Electric Co	Kings River	New	Kings	Calif.	1959	Arch	190	183	O
Pacific Gas & Electric Co	Pacific Gas & Electric Co	Balch	Red.	Kings	Calif.	1956	Arch	388	148	O
Los Angeles Dept of Water & Power	Prof F J Converse; Ralph R Proctor; Chas T Leeds & Chester Marliave	Haas	New	Kings	Calif.	1955	RF	950 3,350	360 270	U
Southern California Edison Co	So. Cal. Edison Co & Bechtel Corp	Pleasant Valley	New	Owen	Calif.	1954	EF	530	116	O
Oakdale & S San Joaquin Irr Dist	Tudor-Goodenough Engrs	Portal	New		Calif.	1955	EF	838	55	O
Oakdale & S San Joaquin Irr Dist	International Engrg Co & George E Goodall Co	Tri-Dam Tulloch	New	Stanislaus	Calif.	1955	CG	1,600	200	I
Oakdale & S San Joaquin Irr Dist		Tri-Dam Donnells	New	Stanislaus	Calif.	1955	CA	800	477	I
Imperial Irrigation District	Gibbs & Hill Inc	Tri-Dam Beardsley	New	Stanislaus	Calif.	1955	EF	1,000	320	I
		Pilot Knob	New	All-American Canal	Calif.	1954	.....	.....	.....	I
U.S. POSSESSIONS										
Petersburg Light & Power Co			New		Alaska	1954	.....	.....	.....	I
Ketchikan Public Utilities	R W Peck & Associates	Ketchikan Lakes	Red.		Alaska	1957	RF	1,197	35	I
Metlakatla Indian Community	Hubbell & Waller Engrg Corp	Purple Lake	New		Alaska	1954	.....	.....	.....	I
Panama Canal Co		Gatun Hydro	Red.	Charges	Canal Zone	1954	.....	.....	.....	I
CANADA					PROVINCE					
Union Electric Light & Power Co	G H Desbarats	Lockston	New	Trinity	N.F.	1954	CG	200	10	I
Union Town Electric Co Ltd	Power Corp of Canada Ltd	New Chelsea	New	Chelsea	N.F.	1955	EF	.....	.....	I
Bowater Power Co Ltd	Shawinigan Engineering Co	Corner Brook	New	Corner Brook	N.F.	1956	CG	98	25	I
Newfoundland Light & Power Co Ltd	Montreal Engineering Co	Rattling Brook	New	Rattling Brook	N.F.	1957	Earth	3,500	40	I
Nova Scotia Power Commission	N.S. Power Comm & K E Whitman	Ridge	New	Bear	N.S.	1956	EF-CW	2,966	42	I
Nova Scotia Light & Power Co		Hemlock Falls	Red.	Avon	N.S.	1957	.....	.....	.....	I
New Brunswick Electric Power Comm	Shawinigan Engineering Co	Beechwood	New	St John	N.B.	1955	CG	680	100	I
Quebec Hydro-Electric Comm	H G Acres & Co; Frazer Brace Engrg	Rapids No. 2	New	Ottawa	Que.	1951	CG	1,026	110	I
Quebec Hydro-Electric Comm	H G Acres & Co	Bersimis No. 1	New	Bersimis	Que.	1953	RF	1,042 2,215	230 200	U
Quebec Hydro-Electric Comm	H G Acres & Co	Bersimis No. 2	New	Bersimis	Que.	1956	CG EF EF	2,000 3,600 3,300	290 40 70	I
Shawinigan Water & Power Co	Shawinigan Engineering Co	Beauharnois No. 3	New	St Lawrence	Que.	1956	P & G	4,500	31	I
Aluminum Company of Canada	H G Acres & Co	Beaumont	New	St Maurice	Que.	1956	CG	1,575	185	S
Manicouagan Power Co	H G Acres & Co	Chute-des-Passes	New	Peribonka	Que.	1956	CG	1,156	170	U
Price Brothers & Co	Montreal Engineering Co	McCormick Dam	New	Manicouagan	Que.	1951	CG	4,575	95	I
Eastern Smelting & Refining Corp	Montreal Engineering Co	Chute Wilson	New	Shipshaw	Que.	1956	.....	.....	.....	I
Gatineau Power Co		Smelter Power	New	Chicoutimi	Que.	1955	CG	460	50	I
James Maclaren Co	Shawinigan Engineering Co	Paugin	New	Gatineau	Que.	1926	CG	.....	.....	I
E B Eddy Co		Dufferin Falls	New	Lievre	Que.	1957	CG	700	64	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Hull	Red.	Ottawa	Que.	1956	.....	.....	.....	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Sir Adam Beck-Niagara No. 2	New	Niagara	Ont.	1948	.....	.....	.....	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Sir Adam Beck-Niagara No. 2	New	Niagara	Ont.	1952	RF	24,967	68	O
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Robert H Saunders	New	St Lawrence	Ont.	1954	CG GG	3,200 3,100	172 126	S
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Manitou Falls	New	English	Ont.	1953	CG	1,069	40	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Whitedog Falls	New	Winnipeg	Ont.	1955	CG	1,130	80	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Caribou Falls	New	English	Ont.	1956	CG;EF	1,800	75	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Alexander Falls	New	Nipigon	Ont.	1926	EF	750	90	I
Hydro-Electric Power Comm of Ontario	Hydro-Electric Power Comm of Ontario	Cameron Falls	New	Nipigon	Ont.	1918	.....	.....	.....	I
Great Lakes Power Co, Ltd	Harza Engineering Co	Silver Falls	New	Kaministikwia	Ont.	1957	.....	.....	.....	I
Great Lakes Power Co, Ltd	Harza Engineering Co	Cat Falls	New	Michipicoten; Shikwamkwa	Ont.	1957	CG & EF EF	1,600 1,400	140 135	I
Great Lakes Power Co, Ltd	Harza Engineering Co	Gartshore Falls	New	Montreal	Ont.	1956	CG	1,100	130	I
Bracebridge Power Lt & Water Comm	H G Acres & Co	Upper Falls	New	Montreal	Ont.	1955	CG	1,380	90	I
Gananoque Electric Light & Water Co	H G Acres & Co	Bracebridge Falls	Red.	North Muskoka	Ont.	1956	.....	.....	.....	I
Miller Bros Ltd		Jones Falls	New	Rideau Canal	Ont.	1946	.....	.....	.....	I
Sherritt-Gordon Mines Ltd	H G Acres & Co	Trenton	New		Ont.	1955	.....	.....	.....	I
Manitoba Hydro Electric Board	H G Acres & Co	Laurie River No. 2	New	Laurie	Man.	1956	CG	1,000	65	I
Churchill River Power & Lt Co		Kelsey	New	Nelson	Man.	1957	RF	850	.....	I
Calgary Power Co	Montreal Engineering Co	Island Falls	New		Sask.	1936	.....	.....	.....	I
Calgary Power Co	Montreal Engineering Co	Cascade Extension	New	Cascade	Alta.	1956	.....	.....	.....	I
Calgary Power Co	Montreal Engineering Co	Rundle	New	Bow	Alta.	1950	Earth	.....	.....	I
		Spray	New	Spray	Alta.	1948	R & EF	625	190	I
Aluminum Company of Canada	B.C. International Engrg Co	Kemano	New	Nechako	B.C.	1951	RF	1,550	319	U
British Columbia Electric Co	B.C. International Engrg Co	Seton	New	Seton & Cayoosh Creek	B.C.	1954	TC CG	800 450	20 25	I
British Columbia Electric Co	B.C. Engineering Co; Dr K Terzaghi & Dr V Dolmage	Cheakamus	New	Cheakmus	B.C.	1954	EF	2,000	90	I
British Columbia Electric Co	B.C. Engineering Co; Dr K Terzaghi & Dr A Casagrande	Bridge No. 2	New	Bridge	B.C.	1956	EF	1,300	175	I
British Columbia Electric Co	B.C. Engineering Co	Clowhom	Red.	Clowhom	B.C.	1956	CG	1,250	73	I
British Columbia Electric Co	B.C. Engineering Co	La Joie	New	Bridge	B.C.	1956	RF	3,390	272	I
British Columbia Power Comm	H G Acres & Co	Ladore	New	Campbell	B.C.	1955	CG	.....	.....	S
British Columbia Power Comm	B.C. Power Comm; H G Acres & Co	Whatshan	New	Whatshan	B.C.	1948	.....	.....	.....	I
British Columbia Power Comm	H G Acres & Co	Upper Campbell Lake	New	Campbell	B.C.	1955	EF	1,700	170	S
Pacific Petroleum Ltd		Dawson Creek	New		B.C.	1956	.....	.....	.....	I
Northern Canada Power Comm	Montreal Engineering Co	Mayo River	New	Mayo	Yukon	1951	Earth	400	100	I
Northern Canada Power Comm	Montreal Engineering Co	Yukon	New	Whitehorse Rapids	Yukon	1956	EF	260	63	I

[1] The term "New" applies to a project on a site not developed before. "Redeveloped" indicates a project on a site that has been developed before and now has new turbines, settings, generators or a new plant.

[2] A&G, arch and gravity; CA, concrete arch; C&E, concrete and earth; CG, concrete gravity; CG&EF, concrete gravity and earth fill; CG, S&B, concrete gravity, slab & buttress, CS&B, concrete slab and buttress; EF, earth fill; EF&RF, earth-faced rock fill; E&RF, earth and rock fill; EF-CW, earth fill with concrete core wall; HF, hydraulic fill; P&G, piers & gates; RF, rock fill; RFCF, rock fill, concrete face; REF, rolled earth fill; SG sector gates; S&R, sluiceways and rock fill; TC timber crib.

[3] I, indoor; S, semi-outdoor; O, outdoor; U, underground.

[4] AC – Allis-Chalmers Mfg Co
AE – American Elin Corp
BB – Brown Boveri Corp
BL – Baldwin Lima-Hamilton Corp
CAC – Canadian Allis-Chalmers Ltd
CBS – Charles Barber & Sons
CGE – Canadian General Electric Co Ltd
CVL – Canadian Vickers Ltd
CWC – Canadian Westinghouse Co Ltd
DEC – Dominion Engineering Co Ltd
EC – Elliott Co
EE – English Electric Co Ltd

Plants in the United States and Canada

Date of initial operation	Initial capacity, hp	Added capacity; No. of units	Date of added capacity	Ultimate capacity, hp	No. of units installed	Hydro-turbine capacity	Hydro-turbine type	Speed, rpm	Static head, ft	Design head, ft	[a] Hydro-turbine manufacturer	[a] Governor manufacturer	Scroll case concrete or steel	Penstock valve, type	Generator capacity, kva	Synchronizing, manual or automatic	[a] Thrust-bearing location	Design power factor	Kilovolts	[a] Generator manufacturer
1961	43,400	..	.....	43,400	2	21,700	Francis	257	319-189	256	.....	.....	Cast steel	Butterfly	16,667	.....	...	0.90	13.8	...
1959	23,500	..	.....	23,500	1	23,500	Impulse [6]	600	1,986-1,960	1,800	AC	W	Cast steel	Rotary	16,842	Automatic	AG	0.95	4.16	PO
1958	556,000	..	.....	834,000	4	139,000	Francis	128.6	277-176	274	MS	W	Plate steel	Head gates	100,111	Manual	BG	0.90	13.8	WE
1959	292,000	..	.....	438,000	4	73,000	Francis	94.8	117-111	115	NN	W	Plate steel	Head gates	52,778	Manual	BG	0.90	13.8	WE
1958	152,000	..	.....	152,000	2	76,000	Francis	225	492-467	421	PB	PB	Cast & pl st	Butterfly	69,000	Automatic	AG	0.90	13.8	GE
1958	50,000	..	.....	50,000	1	50,000	Francis	200	380-295	313	MS	.....	Plate steel	Butterfly	40,000	Automatic	AG	0.90	13.8	GE
1958	152,000	..	.....	152,000	2	76,000	Impulse [7]	240	1,152-1,130	1,110	AC	AC	Cast steel	Butterfly	61,000	Automatic	AG	0.90	13.8	GE
1961	156,000	..	.....	156,000	2	78,000	Francis	300	770	685	.....	.....	Cast & pl st	Butterfly	63,500	Automatic	AG	0.90	13.8	WE
1961	60,000	..	.....	60,000	1	60,000	Francis	.....	793-709	739	.....	.....	Cast & pl st	Butterfly	49,000	Automatic	AG	0.90	13.8	...
1958	46,000	2	1958	180,000	2	67,000	Impulse [6]	400	2,389-2,350	2,293	PB	PB	Cast steel	Spherical	54,000	Automatic	AG	0.90	13.8	AC
1960	184,000	..	.....	184,000	2	92,000	Impulse [7]	400	2,444-2,224	2,324	PB	PB	Cast steel	Spherical	75,000	Automatic	AG	0.90	13.8	WE
1956	4,200	..	.....	4,200	1	4,200	Francis	550	76-52	68	JL	W	Plate steel	Butterfly	4,000	Manual	HS	0.80	4.16	EC
1956	14,000	..	.....	14,000	1	14,000	Francis	300	230	210	MS	W	Welded pl st	Butterfly	10,000	Auto. or Man.	AG	1.00	4.8	GE
1958	24,000	..	.....	24,000	2	12,000	Francis	240	157-74	153	MS	W	Plate steel	Head gates	9,500	Manual	AG	0.90	6.9	EC
1957	74,500	..	.....	74,500	1	74,500	Impulse [7]	240	1,481-1,286	1,151	AC	AC	Cast steel	Butterfly	67,500	Auto. or Man.	AG	0.80	13.8	AC
1957	14,000	..	.....	14,000	1	14,000	Francis	300	264-128	258	AC	AC	Riveted pl st	Butterfly	11,000	Manual	AG	0.90	6.9	AC
1956	52,600	..	.....	52,600	2	26,300	Kaplan	128.6	48	48	BL	W	Concrete	Head gates	20,000	Manual	HS	0.80	4.16	EC
1956	3,100	..	.....	3,100	1	3,100	Impulse	600	.....	1,000	AC	W	Cast steel	.....	2,500	Manual	HS	0.80	4.16	AC
1958	6,500	1	1958	9,000	1	2,500	Francis	720	250-200	250	JL	W	Plate steel	Butterfly	1,750	Manual	BG	0.80	4.16	IE
1956	3,530	..	.....	5,295	2	1,765	Francis	900	321-287	300	JL	W	Cast steel	Butterfly	1,250	Manual	HS	0.80	2.4	EC
1956	13,320	..	.....	20,070	{3	4,440	Francis	257	75	75	PB	PB	Concrete	Head gates	3,750	Auto. or Man.	AG	0.80	6.9	GE
					{1	6,750	Francis	189.5	75	75	PB	PB	Concrete	Head gates	5,625	Auto. or Man.	AG	0.80	6.9	GE
1956	2,000	..	.....	4,000	1	2,000	Francis	720	280-277	270	GGG	GGG	Cast steel	Gate	1,875	Manual	HS	0.80	6.9	CGE
1956	5,600	..	.....	5,600	1	5,600	Francis	514	.....	275	DEC	W	Plate steel	Butterfly	5,000	Auto. or Man.	AG	0.80	6.9	CWC
1958	12,000	..	.....	12,000	2	6,000	Francis	1,000	572	526	EE	W	Welded pl st	Sluice valves	5,100	Automatic	HS	0.90	4.2	EE
1958	17,000	..	.....	17,000	2	8,500	Francis	514.3	330-320	307	CAC	W	Plate steel	Butterfly	7,500	Automatic	AG	0.85	6.9	CGE
1957	5,300	..	.....	5,300	1	5,300	Francis	360	149-147	140	MSC	W	Plate steel	Butterfly	5,000	Automatic	AG	0.80	6.6	CGE
1958	5,000	..	.....	5,000	1	5,000	Francis	360	.....	118	CVL	.....	.....	.....	.....	.....	...	...	...	BB
1958	90,000	..	.....	135,000	2	45,000	Kaplan	109.1	61-20	57	DEC	SGE	Concrete	Head gates	40,000	Manual	BG	0.80	13.8	CGE
1954	48,000	1	1956	64,000	3	16,000	Francis	120	69-64	68	DEC	W	Concrete	Head gates	15,000	Manual	BG	0.85	1CGE; 2CWC	
1956	1,200,000	..	.....	1,200,000	{4	150,000	Francis	277	880-850	785	EEC	W	Plate steel	Spherical	120,000	Automatic	AG	0.95	13.8	MVE
					{4	150,000	Francis	277	880-850	785	NBP	NBP	Plate steel	Spherical	120,000	Automatic	AG	0.95	13.8	CGE
1959	855,000	..	.....	855,000	5	171,000	Francis	163.6	390-350	380	DEC	W	Plate steel	Rotary	120,000	Manual	BG	0.95	13.8	CGE
1959	810,700	..	.....	810,700	{ Beauharnois No. 1 completed in 1949 with 758,000 hp installed, and No. 2 completed in 1953 with 636,000 hp installed															
					{11	73,700	Propeller	94.7	83-76	78	EEC	W	Concrete	Head gates	65,000	.....	BG	0.85	13.8	...
1958	330,000	..	.....	330,000	6	55,000	Francis	120	133-102	124	CAC	W	Welded pl st	Head gates	45,000	Auto. or Man.	AG	0.90	13.8	CGE
1959	1,000,000	..	.....	1,000,000	5	200,000	Francis	200	649-549	540	EEC	.....	Welded pl st	Spherical	165,000	Auto. or Man.	BG	0.90	13.8	CGE
1952	112,400	3	57-58	337,200	{2	56,200	Francis	112.5	128-116	124	MSC	W	Welded pl st	Head gates	37,500	Automatic	AG	0.95	13.8	CGE
					{3	65,000	Francis	112.5	128-116	124	CAC	CAC	Welded pl st	Head gates	50,000	Automatic	AG	0.80	13.8	CGE
1957	80,000	..	.....	80,000	1	80,000	Francis	180	275-270	259	KMK	W	Plate steel	Butterfly	70,000	Automatic	BG	0.90	13.8	CWC
1957	42,000	..	.....	42,000	1	42,000	Francis	257	285-277	278	MSC	W	Welded pl st	Head gates	40,000	Automatic	AG	0.80	13.8	CGE
1928	204,000	1	1956	285,000	{7	34,000	Francis	125	136	133	DEC	W	Plate steel	Head gates	28,500	Manual	AG	0.80	6.6	CWC
					{1	47,000	Francis	128.5	136	133	DEC	W	Plate steel	Head gates	36,000	Manual	AG	0.90	6.6	CGE
1958	50,000	..	.....	50,000	2	25,000	Kaplan	163.6	62	70	EEC	W	Concrete	Head gates	22,500	Automatic	BG	0.85	13.2	CWC
1957	2,900	..	.....	2,900	2	1,450	Francis	164	38	38	JL	.....	Plate steel	Head gates	Connects to existing generators					
1954	1,680,000	..	.....	1,680,000	16	105,000	Francis	150	305-294	292	DEC	W	Plate steel	Head gates	{80,000	Automatic	AG	0.95	13.8	CGE
															{80,000	Automatic	BG	0.95	13.8	CWC
1957	270,000	..	.....	270,000	6	{45,000	Kaplan	92.3	87-40	83	EEC	W	Plate steel	Head gates	31,000	Manual	BG	0.95	13.8	CWC
					{ These units operate in reverse as 55,000-hp, 4600-cfs 75-ft head pumps. Head ranges from 59 to 80 ft.															
1958	1,200,000	..	.....	1,200,000	{8	75,000	Propeller	94.7	.....	81	EEC	W	Concrete	Head gates	60,000	Automatic	BG	0.95	13.8	CWC
					{8	75,000	Propeller	94.7	.....	81	EEC	W	Concrete	Head gates	60,000	Automatic	BG	0.95	13.8	CGE
1956	74,000	1	1958	92,500	5	18,500	Propeller	150	59-44	54	DEC	W	Concrete	Head gates	16,000	Automatic	BG	0.90	13.8	CGE
1958	81,000	..	.....	81,000	3	27,000	Propeller	105.9	54-40	50	DEC	W	Concrete	Head gates	24,000	Automatic	BG	0.90	13.8	CWC
1958	102,000	..	.....	102,000	3	34,000	Propeller	112.5	62-53	58	DEC	W	Concrete	Head gates	28,500	Automatic	BG	0.90	13.8	CGE
1930	73,000	1	1958	92,000	{3	18,000	Francis	100	60-56	58	MSI	W	Concrete	Head gates	15,000	Manual	AG	0.85	12.0	CGE
					{2	19,000	Propeller	150	60-56	58	DEC	W	Concrete	Head gates	15,000	Automatic	AG	0.90	12.0	CGE
1920	75,000	1	1958	100,000	{6	12,500	Francis	120	76-70	72	BL;AC;CVL	W	Concrete	Head gates	10,600	Manual	AG	0.85	CGE;CWC	
					{1	25,000	Propeller	165.5	76-70	73	DEC	W	Concrete	Head gates	20,000	Automatic	BG	0.95	12.0	CWC
1959	60,000	..	.....	60,000	1	60,000	Francis	.....	.....	350	.....	.....	.....	Head gates	43,000	.....	...	...	...	...
1959	30,300	..	.....	30,300	1	30,300	Kaplan	200	116-55	108	DEC	W	Welded pl st	Head gates	22,222	Automatic	BG	0.90	13.8	CGE
1958	30,300	..	.....	30,300	1	30,300	Kaplan	240	118-100	112	DEC	W	Plate steel	Head gates	22,222	Automatic	BG	0.90	11.5	CWC
1956	26,800	1	1956	58,300	1	31,500	Francis	240	247-190	235	MS	W	Plate steel	Head gates	25,000	Manual	BG	0.90	13.8	CWC
1956	1,000	1	1956	1,130	1	580	Francis	400	36	34	CBS	W	Steel	Head gates	300	Manual	HS	0.80	4.16	CGE
1946	2,310	1	1956	3,810	1	1,500	Francis	400	62-56	58	CBS	W	Plate steel	Head gates	1,000	Manual	HS	0.80	2.3	CGE
1956	290	..	.....	290	1	290	Francis	180	14	14	JL	.....	Concrete	Head gates	225	Manual	HS	0.80	2.3	CWC
1957	7,000	..	.....	7,000	1	7,000	Francis	300	60-51	55	EEC	W	Concrete	Head gates	6,000	Automatic	BG	0.90	2.4	CGE
1960	168,000	..	.....	168,000	4	42,000	Propeller	90	47-58	55	.....	.....	Concrete	Head gates	.....	.....	...	...	...	...
1938	57,000	1	1958	133,000	7	19,000	Propeller	150	56	56	DEC	W	Concrete	Head gates	18,000	Manual	AG	0.90	6.6	CGE
1957	23,000	1	1957	46,000	2	23,000	Francis	300	340-320	320	DEC	SGE	Plate steel	Pivot	20,000	Automatic	AG	0.85	13.8	CWC
1951	23,000	1	1958	63,000	{1	23,000	Francis	300	318	318	DEC	W	Welded pl st	Head gates	20,000	Auto. or Man.	AG	0.85	13.8	CWC
					{1	40,000	Francis	300	318	318	DEC	W	Welded pl st	Head gates	35,000	Auto. or Man.	AG	0.85	13.8	CWC
1951	62,000	1	1959	124,000	2	62,000	Francis	450	910	900	DEC	W	Welded pl st	Spherical	55,000	Automatic	AG	0.85	13.2	CWC
1954	450,000	2	1957	2,400,000	{3	150,000	Impulse [6]	327	2,570	2,500	DEC	W	Cast steel	Spherical	114,000	Manual	AG	0.80	CGE;EEC	
					{1	150,000	Impulse [6]	327	2,570	2,500	CAC	W	Cast steel	Spherical	114,000	Manual	AG	0.80	13.8	CGE
					{3	150,000	Impulse [6]	327	2,570	2,500	PB;VIW	PB	Cast steel	Spherical	114,000	Manual	AG	0.80	EEC;CWC	
					{1	150,000	Impulse [6]	327	2,570	2,500	DEC	W	Cast steel	Spherical	114,000	Manual	AG	0.80	13.8	CWC
1957	58,500	..	.....	58,500	1	58,500	Francis	120	167-129	147	CAC	W	Plate steel	Head gates	40,000	Automatic	BG	1.00	13.8	CWC
1957	190,000	..	.....	190,000	2	95,000	Impulse	400	1,125-1,155	1,070	PB;VIW	PB	Cast steel	Butterfly	80,000	Automatic	AG	0.90	13.8	CWC
1959	328,000	..	.....	328,000	4	82,000	Impulse [7]	300	1,351-1,215	1,218	{PB;VIW; NBP}	PB;NBP	Cast steel	{Spherical & butterfly}	65,000	Automatic	AG	0.95	13.8	CWC
1957	40,000	..	.....	40,000	1	40,000	Francis	171	193-130	145	PB;VIW	PB	Plate steel	Butterfly	31,580	Automatic	BG	0.95	13.8	CWC
1957	30,000	..	.....	30,000	1	30,000	Francis	200	260-132	176	CAC	W	Plate steel	Butterfly	24,500	Automatic	BG	0.90	13.8	CGE
1957	70,000	..	.....	105,000	2	35,000	Francis	138.5	126-75	122	DEC	W	Plate steel	Butterfly	30,000	Automatic	BG	0.90	13.8	CGE
1950	33,000	1	1956	66,000	3	16,500	Francis	600	715-667	690	CAC	W	Welded pl st	Butterfly	12,500	Manual	AG	0.90	6.9	CGE
1957	42,000	..	.....	126,000	1	42,000	Francis	138.5	150-80	140	CAC	W	Plate steel	Butterfly	37,500	Automatic	BG	0.90	13.8	CWC
1957	750	..	.....	750	1	750	Francis	786	150	150	JL	.....	Plate steel	Head gates	Drives pump					
1952	3,000	1	1958	6,000	2	3,000	Francis	450	120-110	118	DEC;GGG	W	Plate steel	Butterfly	3,000	Manual	AG	0.85	6.9	CGE
1958	15,000	..	.....	22,500	2	7,500	Francis	257	63	61	KMW	W	Plate steel	Head gates	6,700	Automatic	BG	0.85	6.9	CWC

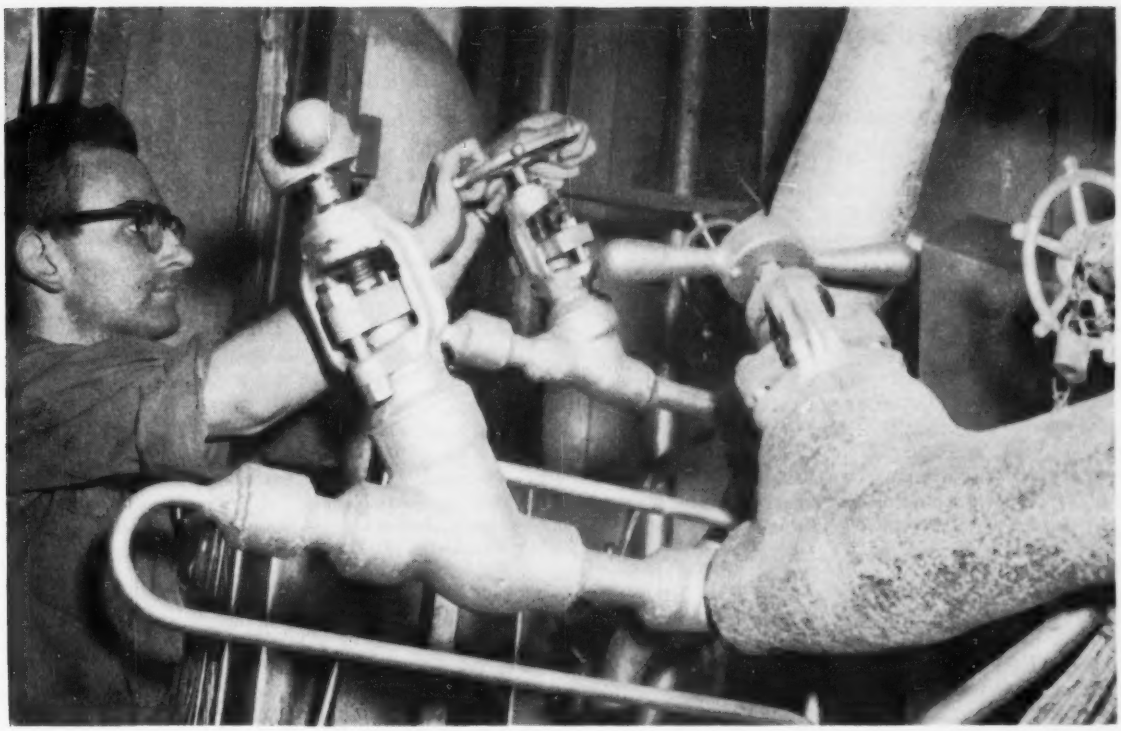
EEC – English Electric Co of Canada Ltd
EM – Electric Machinery Mfg Co
GE – General Electric Co
GGG – Gilbert Gilkes & Gordon Ltd
IE – Ideal Electric & Mfg Co
JL – James Leffel & Co
KMW – KMW of Sweden
L – Lombard Governor Co
MS – S Morgan Smith Co
MSC – S Morgan Smith, Canada Ltd
MSI – S Morgan Smith-Inglis Co
MVE – Metropolitan Vickers Electrical Co Ltd
NBP – (Neyrpic) Neyret-Beylier & Piccard Pictet
NN – Newport News Shipbuilding & Dry Dock Co
PD – Pacific Gerlikon Co
PB – Pelton Div, Baldwin-Lima-Hamilton Corp
SEC – Swedish Electric Co
SGE – Swedish General Electric Co
VIW – Vancouver Iron Works Ltd
W – Woodward Governor Co
WE – Westinghouse Electric Corp

[a] AG, indicates thrust bearing is above generator rotor; BG, thrust bearing is below generator rotor, HS, horizontal-shaft machine.
[6] Vertical-shaft 4-jet type.
[7] Vertical-shaft 6-jet type.

U. S. Government Hydro Power Plants

Government Agency	Project	State or Possession	River	Ultimate capacity, hp	Initial capacity, hp	Installed capacity, hp	On order or being installed, hp
	Eklutna	Alaska	Lake Eklutna	50,000	50,000	50,000	.....
	Grand Coulee	Wash.	Columbia	3,102,000	538,000	3,102,000	.....
U. S. Bureau of Reclamation	Green Springs	Ore.	Emigrant Greek	23,500	23,500	.....	23,500
	Hungry Horse	Mont.	S. Fork Flathead	420,000	420,000	420,000	.....
	Bonneville	Ore. & Wash.	Columbia	729,000	137,000	729,000	.....
	Cougar	Ore.	McKenzie	69,040	69,040	.....	69,040
	Big Cliff	Ore.	North Santiam	26,500	26,500	26,500	.....
	Lookout Point	Ore.	N Fork Willamette	157,500	157,500	157,500	.....
	Detroit	Ore.	North Santiam	140,000	140,000	140,000	.....
	Dexter	Ore.	N Fork Willamette	20,700	20,700	20,700	.....
U. S. Army Engineers	Middle Creek	Ore.	N Fork Willamette	43,400	43,400	.....	43,400
	Chief Joseph	Wash.	Columbia	2,707,000	1,607,000	707,000	900,000
	Dalles	Ore. & Wash.	Columbia	2,770,200	1,779,800	281,600	1,498,200
	McNary Dam	Ore. & Wash.	Columbia	2,226,000	1,565,200	1,565,200	.....
	Ice Harbor	Wash.	Snake	858,000	429,000	.....	429,000
	Albeni Falls	Idaho	Pend Oreille	58,800	58,800	58,800	.....
	Roza	Wash.	Yakima	18,000	18,000	.....	18,000
	Anderson Ranch	Idaho	Boise	55,500	37,000	37,000	.....
	Minidoka	Idaho	Snake	26,500	9,000	19,500	.....
U. S. Bureau of Reclamation	Palisades	Idaho	Snake	158,000	158,000	158,000	.....
	Shasta	Calif.	Sacramento	522,000	419,000	522,000	.....
	Keswick	Calif.	Sacramento	102,000	102,000	102,000	.....
	Folsom	Calif.	American	225,000	225,000	225,000	.....
	Parker Dam	Ariz. & Calif.	Colorado	160,000	120,000	160,000	.....
	Davis Dam	Ariz. & Calif.	Colorado	311,000	311,000	311,000	.....
	Hoover Dam	Ariz. & Nev.	Colorado	1,857,000	522,000	1,742,000	.....
	Glen Canyon	Ariz.	Colorado	1,244,000	1,244,000	.....	.....
	Elephant Butte	N.M.	Rio Grande	34,500	34,500	34,500	.....
	Green Mountain	Colo.	Blue	30,000	30,000	30,000	.....
	Estes Park	Colo.	Colo. Big Thompson	63,000	63,000	63,000	.....
	Pole Hill	Colo.	Colo. Big Thompson	47,500	47,500	47,500	.....
U. S. Bureau of Reclamation	Flatiron	Colo.	Colo. Big Thompson	108,000	108,000	108,000	.....
	Kortes	Wyo.	North Platte	55,000	55,000	55,000	.....
	Shoshone	Wyo.	Shoshone	20,000	20,000	20,000	.....
	Boysen	Wyo.	Big Horn	21,000	21,000	21,000	.....
	Alcova	Wyo.	North Platte	53,000	53,000	53,000	.....
	Glendo	Wyo.	North Platte	33,500	33,500	.....	33,500
	Fremont Canyon	Wyo.	North Platte	67,000	67,000	.....	67,000
	Seminoe	Wyo.	North Platte	45,000	45,000	45,000	.....
	Canyon Ferry	Mont.	Missouri	70,500	70,500	70,500	.....
	Fort Peck No. 1	Mont.	Missouri	150,000	70,000	120,000	.....
	Fort Peck No. 2	Mont.	Missouri	127,000	127,000	.....	127,000
	Fort Randall	S. D.	Missouri	460,000	460,000	460,000	.....
	Oahe	S. D.	Missouri	425,000	170,000	.....	170,000
	Garrison	N. D.	Missouri	440,000	264,000	264,000	176,000
	Gavins Point	S. D. & Neb.	Missouri	162,000	162,000	.....	.....
	St. Mary's Falls	Mich.	St. Mary's	72,750	23,925	23,925	.....
	Norfolk	Ark.	North Fork	168,000	42,540	84,540	.....
U.S. Army Engineers	Blakely Mountain	Ark.	Ouachita	104,000	104,000	104,000	.....
	Bull Shoals	Ark.	White	419,000	211,000	211,000	.....
	Greers Ferry	Ark.	White	132,600	132,600	.....	.....
	Table Rock	Ark.	White	274,000	138,000	.....	138,000
	Dardanelle	Ark.	Dardanelle	167,000	167,000	.....	.....
	Narrows	Ark.	Little Missouri	36,000	24,000	24,000	.....
	Eufaula	Okla.	Canadian	138,000	138,000	.....	138,000
	Fort Gibson	Okla.	Grand	96,000	64,000	64,000	.....
	Tenkiller Ferry	Okla.	Illinois	47,000	47,000	47,000	.....
	Dennison Dam	Okla. & Texas	Red	282,080	56,080	114,080	.....
International Boundary & Water Comm.	Falcon Dam	Texas & Mex.	Rio Grande	88,500	88,500	88,500	.....
	Whitney Dam	Texas	Brazos	41,400	41,400	41,400	.....
U. S. Army Engineers	Barkley	Ky.	Cumberland	232,000	232,000	.....	.....
	Wolf Creek	Ky.	Cumberland	377,000	377,000	377,000	.....
	Kentucky	Ky.	Tennessee	220,000	176,000	220,000	.....
	Pickwick	Tenn.	Tennessee	302,000	96,000	302,000	.....
	Wilson	Ala.	Tennessee	610,000	206,000	610,000	.....
	Wheeler	Ala.	Tennessee	360,000	90,000	360,000	.....
	Guntersville	Ala.	Tennessee	141,000	120,000	141,000	.....
	Hales Bar	Tenn.	Tennessee	140,000	72,000	140,000	.....
	Chickamauga	Tenn.	Tennessee	144,000	108,000	144,000	.....
	Watts Bar	Tenn.	Tennessee	210,000	120,000	210,000	.....
	Norris	Tenn.	Clinch	132,000	132,000	132,000	.....
	Fort Loudoun	Tenn.	Tennessee	176,000	88,000	176,000	.....
Tennessee Valley Authority	Cherokee	Tenn.	Holston	166,000	83,000	166,000	.....
	Douglas	Tenn.	French Broad	154,000	83,000	154,000	.....
	South Holston	Tenn.	South Holston	49,500	49,500	49,500	.....
	Ft. Patrick Henry	Tenn.	S Fork Holston	50,000	50,000	50,000	.....
	Boone	Tenn.	S Fork Holston	103,500	103,500	103,500	.....
	Watauga	Tenn.	Watauga	69,000	69,000	69,000	.....
	Fontana	N. C.	Little Tennessee	274,000	183,000	274,000	.....
	Apalachia	Tenn.	Hiwassee	106,000	106,000	106,000	.....
	Hiwassee	N. C.	Hiwassee	160,000	80,000	160,000	.....
	Nottely	Ga.	Nottely	21,000	21,000	21,000	.....
	Ocoee No. 3	Tenn.	Ocoee	33,500	33,500	33,500	.....
	Ocoee No. 2	Tenn.	Ocoee	25,000	20,000	25,000	.....
	John H Kerr	Va. & N.C.	Roanoke	290,000	290,000	290,000	.....
	Philpott	Va.	Smith	19,640	19,640	19,640	.....
	Central Hill	Tenn.	Carney Fork	188,750	188,750	188,750	.....
	Dale Hollow	Tenn.	Obey	75,000	50,000	75,000	.....
	Old Hickory	Tenn.	Cumberland	180,000	180,000	180,000	.....
U. S. Army Engineers	Cheatham	Tenn.	Cumberland	60,000	60,000	.....	60,000
	Allatoona	Ga.	Etowah	152,000	102,900	102,900	.....
	Buford	Ga.	Chattahoochee	118,400	118,400	118,400	.....
	Fort Gaines	Ga. & Ala.	Chattahoochee	118,400	118,400	.....	118,400
	Jim Woodruff	Fla.	Chattahoochee	42,000	42,000	42,000	.....
	Clark Hill	Ga. & S. C.	Savannah	388,600	388,600	388,600	.....
Total Capacity				28,550,000	17,770,450	17,905,100	2,885,000

Note: Because of space limits, 12 plants of 19,000 hp and below, totaling 104,000 hp, have been omitted.



TEST ENGINEER checks special ½-in.-high-pressure valve at Ohio Power's Philo station

Now, a 4500-psi standard for valves?

- **High-pressure boilers over 2500 psi call for special, expensive valve designs. Many other industries also use valves at pressures higher than existing ASA standards**
- **Industry-wide standards mean dollar savings for all concerned . . . even those whose need is infrequent and small**
- **Critical pressure creates a sort of "no man's land" in boiler development. So there may never be any great demand for valves in a 3000-psi range**
- **Recent survey of prominent engineers revealed strong preference for a 4500-psi standard. It has added advantage of numerical simplicity with technical practicality**
- **On the following pages, W F Crawford urges adoption of a 4500-psi standard series now**

By **W F CRAWFORD,** *President*
Edward Valves Inc, subsidiary of Rockwell Manufacturing Co

New 4500-psi class will simplify pipe and valve selection

► NOW, THE POWER INDUSTRY joins other industries using valves at pressures higher than existing ASA standards. Supercritical boiler development is the main reason. And high operating temperatures give the valve designer a doubly tough nut to crack.

CHEMICAL PROCESS VALVES

Chemical process industry was an early user of extreme-pressure valves. Coal hydrogenation, some oil refining processes and the manufacture of ammonia and other basic chemicals are good examples. Valves and fittings are of varied size and design. Since processes change rapidly with advancing technology, each valve need is usually met and solved on an individual basis. There isn't any consistent demand for manufacture of a uniform series in this high-pressure range. So it hasn't been feasible to develop a new standard class.

Yet, adoption of standards for the extreme pressures becoming more common in the power field will benefit all industries concerned—including those where the need is infrequent and small in volume.

PROGRESS AT LOW TEMPERATURES

The oil production industry encounters extreme pressures in drilling very deep oil wells. Solution to this problem was development of the API-2900 series of valves, flanges and fittings. Practically all these high-pressure applications are at or near atmospheric temperatures. So lubricant seals or rubber seals are satisfactory. But high boiler-operating temperatures prohibit their use in the power industry. Alloy steels used for API-2900 series flanges pose a problem too. They rapidly lose strength at elevated temperatures.

HIGH-TEMPERATURE NEEDS

When the development of supercritical boilers began, there was very little extreme-pressure information available from other industries. And there was even less on extreme pressures at extreme temperatures. Because supercritical boilers seemed inevitable, a special valve study and experimentation program was started.

This program has been going on for several years now. A number of experimental valves have been manufactured. Tentative designs have been developed and a few types and sizes of valves have been made for the first American supercritical boiler.

Now is the time to adopt a new standard for this extreme-pressure range. It will mean dollar savings in the design and procurement of components for tomorrow's supercritical boilers.

CHOOSING THE NEW STANDARD

Proposing a new standard-pressure series raises some questions, of course. What will be its relationship to previous standard-pressure classes? The 1500-psi class represents a 66% increase in pressure over the 900-psi class. The 2500-psi class represents a 66% increase over the 1500-psi class.

Another 66% increase gives an odd figure of about 4200 psi. This is undesirable for a number of reasons.

First, a survey of prominent engineers in the utility business was conducted recently by the Manufacturers Standardization Society of the Valve and Fitting Industry. It revealed a natural preference for the numerically convenient designation of 4500. This is an increase of 80% over the existing 2500-psi class.

Second, the fact that critical pressure for steam and water is near 3200 psi creates something of a "no man's land" in boiler development. Drum boilers will definitely stay below this figure. But once-through types can exceed it quickly.

It's possible that there may never be a great demand for boilers operating in the 3000-psi range. So a jump to the 4500-psi class seems reasonable. In fact, the time may come when the industry will look back on this move as being too conservative.

The 4500-psi class is just three times the pressure rating of the existing 1500-psi class. This makes it a simple matter to quickly compute allowable pressure at any temperature. Merely look up the ASA 1500 psi for the service temperature in almost any reference table. Then multiply it by three to get allowable pressures for the 4500-psi series. Only exception to this is the high-temperature region. Here, a plasticity factor must be applied to the pressure rating (ASA B31.1 *Code for pressure piping*, paragraph 122).

Heavy wall conditions exist in the extreme-pressure range. And plasticity factor has a big effect on design allowances. Table, facing page, gives allowable pressures for the 4500-psi series over foreseeable temperature ranges.

DESIGNING THE VALVE

In valve design the weight of pipe used in a high-pressure system is quite important. Unfortunately there is no pipe standard over schedule-160. For the pressure class considered here, room temperature-pressure rating is near 10,000 psi. Ordinary steel pipe with an allowable fiber stress of 20,000 psi gives a pressure to stress ratio of 0.5. This is equivalent to a theoretical schedule-500 pipe in ASA terminology.

The valve designer starts with the nominal outside diameter of existing ASA pipe and calculates the internal bore for schedule-500 pipe. This internal diameter must match the proposed high-pressure valve design.

Calculations for pipe sizes from ½ to 24 in. give a series of internal di-

Valve body thickness for 4500-psi standard series

Valve dimensions		Valve body minimum wall thickness	
Nominal size	Port diameter	Center section	At welding end
¾" - 1"	½"	*	*
1-½" - 2"	1"	*	*
2-½" - 3"	1-⅝"	*	*
4"	2-⅜"	1-⅞"	1-⅛"
5"	2-⅞"	2-5/16"	1-½"
6"	3-¾"	3"	2"
8"	4-¾"	3-¾"	2-½"
10"	5-¾"	4-9/16"	3"
12" - 14"	7"	5-½"	3-¾"
16" - 18"	8-¾"	7"	4-¾"
20"	10-¾"	8-½"	5-½"
24"	13"	10-¼"	6-¾"

*Forged valve bodies may have socket or butt welding ends and are contoured to provide suitable stress levels at each localized section. They are not generally designed in accordance with ASA B16.5.

Pressure-temperature rating of welding end, pressure-seal valves

Valve materials	Service temperature, F	Primary service pressure ratings, psi: 600	900	1500	2500	4500
		Hydrostatic shell test pressures, psi: 2175	3240	5400	9000	16,200
		Maximum non-shock service pressure ratings, psi				
	100	1440	2160	3600	6000	10,800
	150	1420	2130	3550	5915	10,650
	200	1400	2100	3500	5830	10,500
	250	1380	2070	3450	5750	10,350
Carbon steel	300	1365	2050	3415	5690	10,200
1-¼ Cr - ½ Mo	350	1350	2025	3375	5625	10,050
2-¼ Cr - 1 Mo	400	1330	2000	3330	5550	9,900
18-8 Mo.	450	1305	1955	3255	5430	9,750
	500	1250	1875	3125	5210	9,400
	550	1180	1775	2955	4925	8,850
	600	1110	1660	2770	4620	8,350
	650	1030	1550	2580	4300	7,700
	700	940	1410	2350	3920	7,075
Carbon steel	750	850	1275	2125	3550	6,350
	800	730	1100	1830	3050	5,450
	850	600	900	1500	2500	4,500
	700	940	1450	2415	4025	7,225
	750	900	1350	2250	3745	6,750
1-¼ Cr - ½ Mo	800	850	1275	2125	3550	6,425
2-¼ Cr - 1 Mo	850	810	1220	2025	3375	6,050
	900	765	1150	1910	3180	5,725
	950	725	1090	1830	3100	5,325
	1000	685	1050	1790	2800	4,920
1-¼ Cr - ½ Mo	1050	480	815	1260	2200	4,500
2-¼ Cr - 1 Mo	1050	510	775	1330	2325	4,500
	1100	370	560	960	1680	3,350
	700	990	1480	2475	4125	7,400
	800	915	1370	2280	3800	6,850
	900	860	1290	2140	3575	6,425
	1000	810	1210	2020	3360	6,050
18-8 Mo	1050	780	1170	1950	3250	5,850
	1100	760	1150	1925	3150	5,700
	1150	670	1015	1740	3040	5,550
	1200	600	910	1550	2720	5,400
	1250	465	710	1210	2120	4,225

Carbon steel _____ Castings ASTM A216 Grade WCB, Forgings A105 Grade 11
1-¼ Cr—½ Mo_____ Castings ASTM A217 Grade WC6, Forgings A182 Grade F11
2-¼ Cr—½ Mo_____ Castings ASTM A217 Grade WC9, Forgings A182 Grade F22
18-8 Mo_____ Castings ASTM A351 Grade CF8M, Forgings A182 Grade F8m

mensions for valve flow passages in the proposed 4500-psi class.

Next step is to calculate valve wall thickness from existing ASA formulas. (ASA B16.5). Resulting series of minimum wall thickness will be somewhat greater than adjacent pipe thickness. The extra material is needed for machining both inside and outside welding ends of the valve to match the heavy wall pipe. Table, facing page, shows calculated thickness of each valve body in the new 4500-psi standard.

Note that some valve sizes are combined on the table. This is easily explained. Start with the outside diameter of the pipe and add the required material to the inside. Resulting hole for high pressures is quite small. Seventeen pipe sizes between ¾ and 24 in. give seventeen internal valve diameters falling between ½ and 13 in. There are far too many sizes to be practical.

Certain pipe sizes are, therefore, best covered by a single valve size. For example, the ¾- and 1-in. valves are combined with a ½-in. port diameter. The 1½- and 2-in. valves are combined with a 1⅝-in. port diameter. In each case all valves are designed with enough metal on the ends to match either of the two pipe sizes.

At the present time, these valves are

proposed only with welding-end connections; no provision is made for a flange series. Our practice is to use welding-end connections and pressure-seal bonnet connections for high-pressure high-temperature valves. Screwed and seal welded or integral connections are used only for smaller valves. This practice is also recommended for the proposed 4500-psi series. Valves can then be rated independently of stress limitations imposed by flanges.

Special ratings are used for valves in the temperature range above 850 F, (see explanation below). Table of allowable valve pressures shows the result of applying our special ratings to the new series. It also includes all classes from 600 to 4500 psi in a number of commonly used materials.

New 4500-psi ratings are three times those for 1500 psi up to 850 F in both ferritic and austenitic steels. Variance beyond this point is caused by the plasticity factor.

Engineers working with problems in supercritical boilers should make every effort to use the proposed 4500-psi class. It will make considerable savings possible in valve selection. Use recommended inside dimensions shown on the table to help size both lines and valves.

For example, a line requirement of 6500 psi at 700 F calls for an inside diameter of 5 in. This can be handled by an 8-in. 4500-psi, carbon-steel valve.

If the job demands a valve with an ½-in. opening for 5000 psi at 1150 F, a 1-in. 4500-psi valve constructed of 18-8 Mo is suitable.

The new standard series will reap the dollar savings inherent in all industry-wide standards. And it offers the added advantages of numerical convenience and technical practicality.

Here's how special valve ratings are computed

Special valve ratings can be developed for pressure-sealed bonnet valves from allowable stresses in (1) ASME *Boiler code* (2) ASA *Code for pressure piping* and (3) ASA *Standard B16.5 for steel pipe flanges and flanged fittings.*

Resulting ratings are higher at high temperatures than those given in the pressure-temperature tables of B16.5-1953. There is a good reason for this. Normal maximum stress used to prepare this standard is 8750 psi (ASA B16.5-1953 Appendix D, page 74), but maximum stress in valve bodies without flanges is 7000 psi. So this lower figure must be used to select primary temperature following the same procedure given in Appendix D, 2a. Valve design is fully in accord with wall-thickness requirements of the ASA Standards (See paragraph 6.1 of the introductory notes).

Curves, right, show allowable stresses used to compute the special valve ratings. High-temperature region between circled points is taken directly from Table P7, 1952 ASME *Boiler code.* Stress values at all lower temperatures fall below those listed in this table. These lower values are the same as pressure-temperature ratings for Class-A flanges in the range of 100 to 750 F (ASA B16.5).

Decrease from allowable ASME stresses is partly due to strength limitations imposed by existing valve mechanisms such as stem and yoke bushing strength, handwheel proportions, etc.

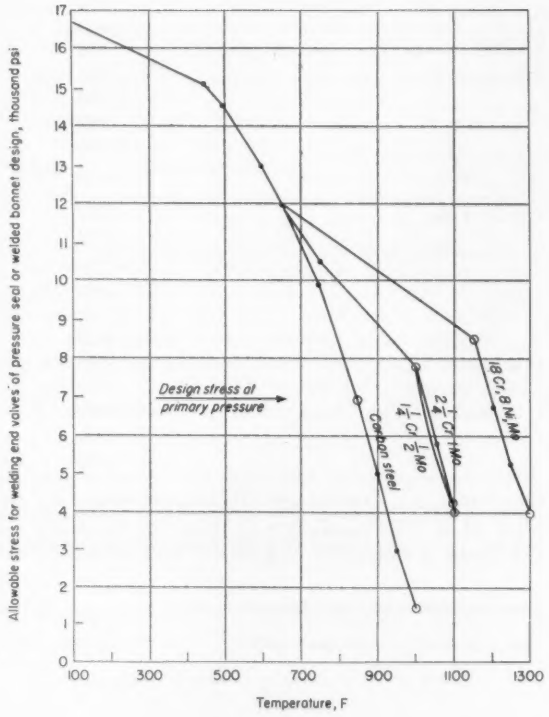
The special or secondary valve pressure rating at a given temperature is given by the formula:

$$p = \frac{sP}{S - P(y - 0.4)}$$

where

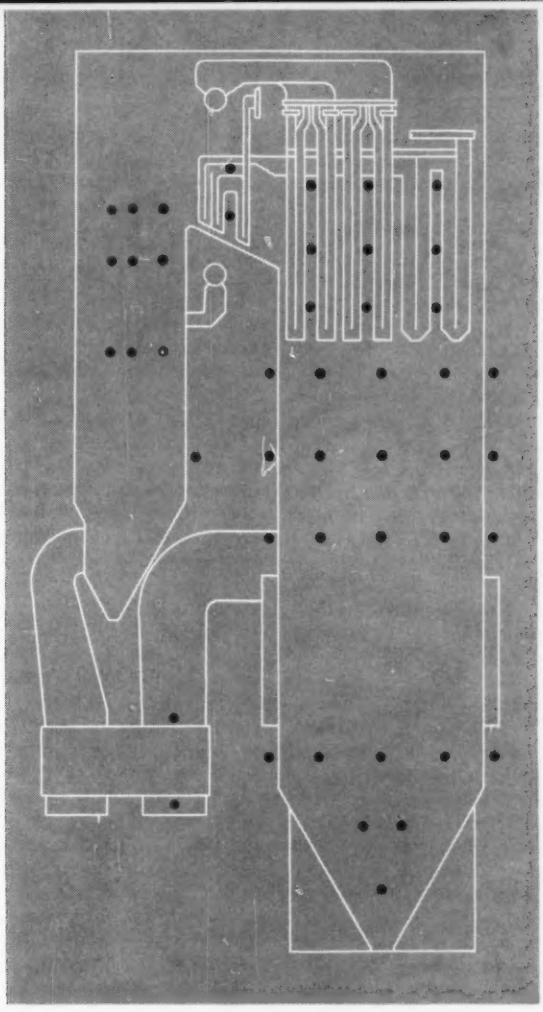
p = secondary pressure rating at selected temperature
s = allowable stress at selected temperature
P = primary pressure (600, 900, 1500 or 2500 psi)
S = primary stress (7000 psi)
y = plasticity factor (as defined on page 3 of the supplement to the *Pressure piping code,* ASA B31.1a-1953)

	Plasticity factor					
Steel type	900 F and below	950 F	1000 F	1050 F	1100 F	1150 F and above
Ferritic	0.4	0.5	0.7	0.7	0.7	0.7
Austenitic	0.4	0.4	0.4	0.4	0.5	0.7



Use the formula above to calculate pressure-temperature rating for each valve temperature and pressure class. At a given temperature, materials with the same allowable stress will have identical pressure ratings. In those temperature regions where allowable stresses differ with materials, pressure ratings must be calculated separately. The special pressure-temperature ratings are calculated from this basic formula. These are tabulated on preceding page for easy reference.

By R G ELMENDORF,* *Majac, Inc*



TODAY'S BOILERS need an ever-increasing number of blower units. Their cost can add up to 5% of total boiler cost

Today's soot-blower design

An increasingly important factor for economical boiler operation

► BASICALLY, a soot blower is a mechanism to direct jets of a fluid energy medium over a boiler's fouled fireside surfaces and to blow off slag and ash deposits. Various blower types which accomplish the same result differ only because of particular tube arrangements in the boiler's various sections. The blower types now widely used in central stations are (1) wall blowers (2) long retractable blowers and (3) air-heater blowers. Another type, the rotary blower, is a low-temperature-zone unit whose use has declined somewhat except in smaller and packaged boilers.

The wall blower projects just inside the furnace and rotates a nozzle through a 360-deg arc. The jet projects approximately parallel to the furnace wall, thus cleaning within a circular area on the wall. Cleaning range varies from 4 ft in heavy running slag to 6 ft or more in light, solid deposits.

Long retractable blowers, available with up to 40-ft travel, project well into the boiler, much like a horizontal flagpole, and rotate while extending. The effective cleaning path becomes a helix and covers a solid cylindrical volume. Usually, the retractable blower has jets only at the tip of the lance and retracts completely from the furnace after its operation. Sometimes, however, with a second or third set of nozzles added, the blower travels only 1/3 or 1/2 of its length. Used in the boiler's cooler zones where the lance can be left exposed to furnace gases, this type costs less than full-travel units. Cleaning effectiveness is more or less a compromise between a standard retractable blower and a rotary blower.

Air-heater blower types are (1) a swing-arm unit for cleaning regenera-

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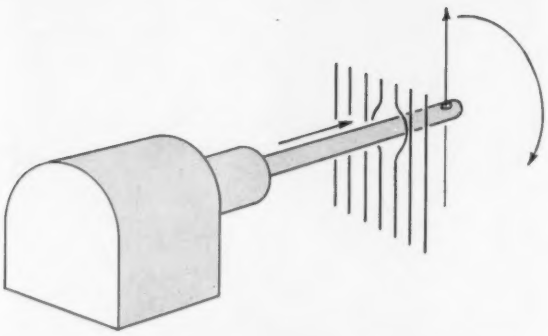
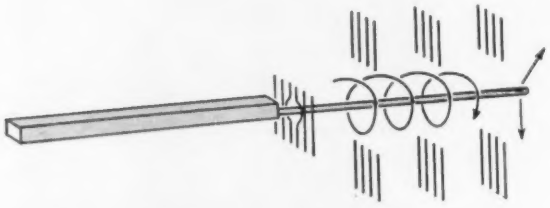
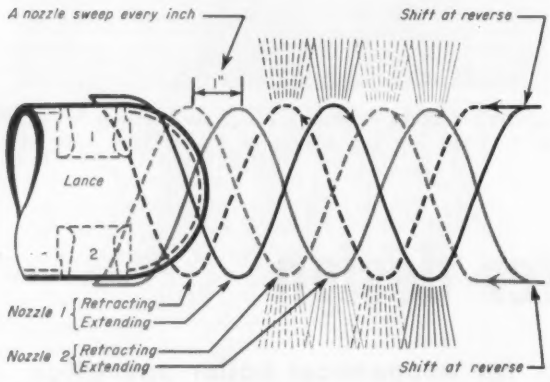


WALL BLOWER projects just inside furnace wall, rotates a nozzle through 360-deg arc, cleans circular area on wall



LONG RETRACTABLE BLOWER rotates while extending. Usually having jets only, at lance tip, units travel up to 40 ft



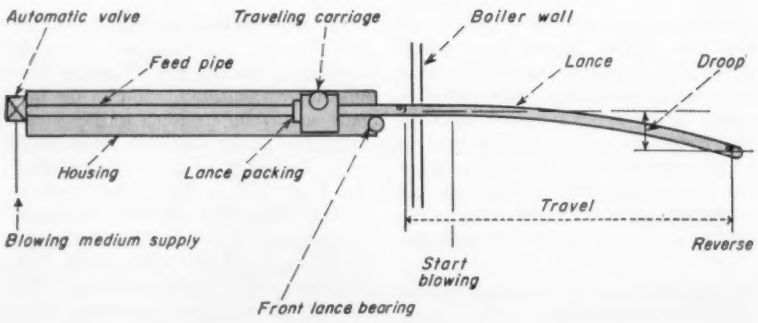
CLEANING PATH of long retractable blower is a helix and covers a solid cylindrical volume. Added nozzles cut travel

tive heaters and (2) a traveling-frame type for cleaning tubular heaters. The swing-arm blower swings a single nozzle in a transverse arc as the heater element rotates, cleaning in a close spiral path. The traveling-frame unit pushes a multiple-nozzle crossarm back and forth across the ends of the heater tubes, cleaning a complete row of tubes at each indexed position.

Automatic control systems for soot blowers become more and more necessary as number of blowers per boiler increases. Such systems are used extensively in power plants today, and in the future, as the remote-controlled power plant becomes a reality, the systems will play an important part in the overall operation.

Today's blowers are, of course, designed for automatic start, blowing medium turn-on, reversing and shutoff. An automatic sequential control system energized by the boiler operator in the control room can initiate starting, in sequence, of a number of blowers scattered over the boiler. However, this system is in no sense a "brain" because the operator must set up the sequence as dictated by his observation of slag conditions in the boiler. Then the system takes over and runs through the selected blowers. It monitors their operation and initiates corrective or emergency action should a blower malfunction. It can start the sequence over and over again at certain hours of the day and can be tied in with boiler controls, such as burner tilt position, but it has no judgment with regard to effectively selecting blower groups for economic cleaning. This still depends on the skill of operators or supervisory personnel.

Master control panels in the control room may include instruments to indi-



COMPLEX design of long retracting unit illustrates trend toward costly but more efficient blowers. Lance packing is the major problem

cate blowing medium pressure and flow, drive motor power, blower position, unit operating, alarm lights and others. They may include switches for selecting, starting or by-passing units in the sequence. They may also include a boiler diagram having lights indicating blower locations. A typical pattern might be to blow one or two bands of wall blowers in response to a rise in superheat temperature beyond the vernier boiler control. Then, space retractable blower operation in the superheater and reheater through the shift until the superheat temperature again rises to the limit of the vernier control (burner tilt, gas recirculation, etc.), and repeat wall-blower use. Cold end blowers (economizer, air heater) would be blown perhaps once a shift to cut draft loss and keep flue-gas temperatures efficiently low.

Steam and air are the fluid mediums generally used for blowing. Steam was used almost exclusively until recent years but compressed air is now used on many installations. The jet impingement on the slag or ash, coupled with hot-slag quenching in furnace zones and turbulence in low-temperature passes, is what actually does the cleaning. In some instances, of a pioneering nature, solid pellets like buckshot projected from a high-pressure air blower have been effective where slag deposits are inaccessible or too heavy for conventional jets.

Air vs steam. Many analyses made and opinions advanced on relative merits of steam or air as a blowing medium boil down to something like this: for air blowing, the claims are (1) less blower and valve maintenance (2) less air heater plugging (3) cleaner in overall use and (4) no boiler-water makeup. Steam blowing enthusiasts claim their system means (1) cheaper operating cost (2) unlimited availability for difficult or continuous cleaning and (3) no capital investment in compressors.

Steam claim No. 1 is sometimes challenged by air proponents, but careful study reveals that in these cases quoted figures on air consumption have usually been trimmed to the bone, while quoted steam consumption figures are less conservative. With regard to claim No. 3, it must in all fairness be said that in supercritical-pressure boilers, bleed steam isn't readily available from the unit because of undesirable contaminating effect of makeup water. The necessity for auxiliary soot-blowing boilers would partially offset the high capital investment in air compressors.

Both air and steam have been claimed to clean better. In discussing any cleaning medium, it's well to remember that in terms of the jet energy needed to remove deposits, the *type of blowing medium* has little effect. This assumes that the chilling effect needed to solidify soft slag is available from either air or steam at all temperatures normally used. Soda pop, for example, would be as effective as steam or air if it were cheap enough in terms of available energy content.

Kinetic energy of a jet is measured by the formula $MV^2/2$, where M is the fluid's mass flow and V is the stream's velocity. Mass flow through a venturi nozzle (used in modified forms on all blowers today) can be varied by changing (1) throat size (2) upstream pressure (3) upstream temperature or (4) the fluid. Critical flow occurs in all cases, since blowing pressures are above 50 psi. Velocity depends only on the fluid and its upstream temperature. So it's evident that blowing mediums should be compared on the basis of equal jet energies instead of relying on empirical quoted consumption figures.

Superheated low-pressure air isn't used on any large-scale installations today, though it may gain popularity in the future. Its economy compares with steam's and it retains other advantages of air. Savings result from adding more energy to the air in the form of heat, which costs about 40c per million Btu, rather than adding more energy in the form of pressure, which is available for not less than $1 per million Btu. In terms of cost per unit of jet kinetic energy, a rough breakdown shows that superheated steam and superheated air each cost about 75% as much as saturated steam, and 50% as much as compressed air.

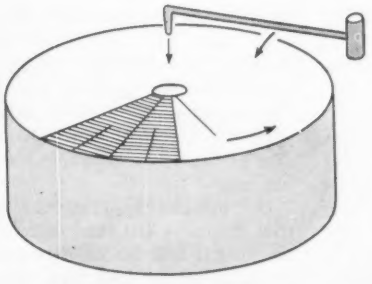
Soot-blower maintenance gets considerable attention from those in the power field concerned with this equipment. In general, today's soot blowers haven't the inherent mechanical reliability of many other plant auxiliaries. High maintenance costs (up to 25% of total maintenance in some plants) chiefly result from the greater number of blowers on today's boilers. For example, a small problem on each of 100 wall blowers adds up to a substantial overall cost. Further, automatic blower operation means a complex drive and control system which takes some attention and has parts that are relatively expensive to replace.

Blower-maintenance cost evaluation and comparative costs between plants or between manufacturers should be a part of every user's plant analysis. Soot-blower costs should be segregated from other equipment costs.

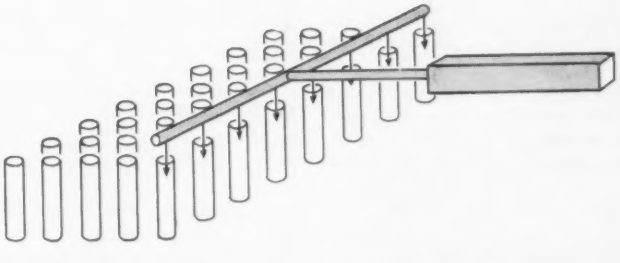
Design problems currently challeng-

(*Continued on page* 214)

Air heaters



SWING-ARM, with single nozzle, sweeps in a transverse arc as the regenerative heater element rotates



TUBULAR heater has traveling multiple-nozzle blower which cleans row of tubes at each indexed position

INSULATED MAINS in new transmission system snake toward steel mill's steam plant. Including pipe-expansion joints, actual length of line is almost 6000 ft. Revised system also has 12-in. line supplying the steam for new turbo-blower equipment

New steam-transmission system at a large eastern steel mill includes a 20-in. main carrying 250-psi, 650-F steam about 5000 ft between steam-generating stations. It's a prime example of why it pays to . . .

Use economical insulation thickness

► INCREASED power generation from a topping turbine at this plant is the result of furnishing an additional outlet for its exhaust steam. The new steam-transmission system includes a 20-in. line connecting two steam-generating stations about 5000 ft apart. Counting expansion joints, the actual length of this line is almost 6000 ft. The revised system also includes a 12-in. line supplying a new turbo-blower. Both new lines parallel for 1500 ft an existing main that supplies steam to the electric power-generating station.

Since the cost of lost heat from a system like this can be staggering, the insulation problem calls for careful study. Here is a case in which it pays to calculate and use the most economical insulation thickness.

Economical insulation thickness can be calculated exactly for any given set of conditions. It varies with (1) annual hours of operation (2) rate of insulation-cost amortization (3) cost of heat production per million Btu (4) rate of heat loss through insulation in Btu per hour (5) operating temperature (6) applied cost of insulation per linear foot and (7) pipe size.

Annual cost of heat loss through the insulation and annual cost of the insulation itself varies with respect to each other as insulation thickness changes. As insulation thickness increases the cost goes up, but the heat loss decreases. So most economical insulation thickness occurs when the sum of these two annual costs is at a minimum.

One practical approach is to select a trial thickness and then calculate both the annual cost for insulation and the resulting annual heat loss. Then take several thicknesses of insulation above and below the trial thickness and compute their comparative costs on the same basis. The lowest total annual

EXPANSION BEND in new steam main is insulated with calcium silicate and given a weatherproof finish. Most economical insulation thickness on this line is 4 in.

Summary of annual insulation costs

Insulation thickness inches	Heat loss Btu/ft/hr (still air)	Annual cost heat loss per ft	Estimated cost applied insulation per ft	Annual cost insulation tion per ft	Total annual cost of insulation and heat loss per ft
none	18,380	$48.30	—	—	$48.30
2	685	1.80	$9.50	$1.42	3.22
2½	568	1.49	10.00	1.50	2.99
3	490	1.29	11.50	1.73	3.02
3½	428	1.12	12.00	1.80	2.92
4	385	1.01	13.00	1.95	2.96
4½	358	.94	15.00	2.25	3.19

cost will indicate the most economical insulation thickness.

Insulation engineers based this job study on the use of calcium silicate and the following data:

(1) Heat value—$0.30 per 10^6 Btu

(2) Operation—8760 hrs/yr (24 hrs, 365 days)

(3) Fixed insulation charges—15% per year

(4) Ambient temperature—50 F (still air)

Approximate economical insulation thickness recommended by the insulation manufacturer is one starting point for the calculations. Actual cost of heat loss plus amortized insulation is computed for thicknesses above and below the original selection. In this study the thicknesses range from 2 in. to 4½ in. of calcium silicate. Average conductivity (k factor) established by the MIMA is used. Result of these calculations is shown on above table.

On this table the theoretical economical insulation thickness is 3½ in. Its total annual cost is $2.92 compared with $2.96 for 4-in. insulation. This total annual cost includes both amortized insulation cost and the resulting annual heat loss. These calculations are based on heat loss under still-air conditions. But this outdoor main is subject to wind velocities averaging 15 mph. Taking this added factor into account the most favorable insulation thickness is actually 4 in.

Cost of heat loss from uninsulated pipe is included for comparison. It's interesting that at $48.30 per lin ft, the waste on this 6000-ft main runs about $289,000 annually. Compare this to the heat loss of $6,060 per year from the same pipe with 4 in. of insulation. With this much amortized insulation included at original estimates the annual cost increases to $17,760.

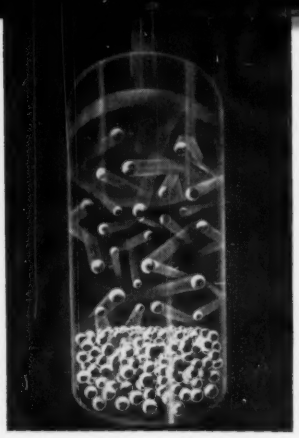
Neither 2 nor 2½ in. of insulation showed up favorably in this economical-thickness comparison. But when they do there are other factors to take into consideration. Both these thicknesses are usually applied in a single layer. This does reduce the application costs somewhat, but the saving is more than offset by higher heat loss through joints in the insulation that are opened by pipe expansion. This extra loss is hard to compute and is usually not included in the calculations. In addition to the higher heat loss occurring with this setup, the expansion may damage the insulation jackets, increasing maintenance costs.

The 4-in. calcium-silicate insulation is applied in double-layer construction with butt and longitudinal joints staggered between layers. Each individual layer is secured with three loops of 18-gage galvanized annealed wire per 3-ft section. Insulation on the outdoor main is finished with a weatherproof jacket of asphalt-saturated asbestos felt secured with stainless-steel bands on 6-in. centers.

Bends, valves, flanges and fittings are insulated with sectional or block insulation of the same thickness, with a coat of asbestos and portland cement. Surface is finished with troweled ¼-in. thick (wet) plastic weatherproofing.—*Courtesy of Magnesia-Silica Insulation Manufacturers' Association, Washington, D.C.*

THERMO REFRESHER NO. 14

By B G A SKROTZKI, *Associate Editor*



Here, we start our study of practical thermodynamic machines, reciprocating air and gas compressors. The processes and problems of these machines in handling energy will lay a foundation for understanding heat engines later. Now let's learn . . .

How to send energy by compressed air

► LAST MONTH we studied some ideal engine cycles; but before looking at the problems of practical heat engines let's study the operation of compressed-air systems. These involve relatively simple types of reciprocating machinery and will help us in understanding heat engines later on.

Compressed air has many practical uses: (1) driving air engines for drilling, grinding, sawing, etc (2) driving reciprocating pistons in mechanical hammers (3) atomizing liquids as in paint spraying (4) conveying solid and powdered materials in pipelines (5) transmitting control-system pressures to remote locations (6) pumping water by air lift (7) cleaning surfaces by air blast.

A compressed-air system transmits energy; in some situations it has more flexibility and safety than other energy-transmitting systems that might be used. An air compressor produces pressurized air that carries energy to the point of use. In some industrial operations compressors pressurize gases other than air — generally the conditions to be met and the results parallel those for air compressors. In this part we will only cover reciprocating compressors—other types will be discussed later in the series.

Air compressors. Fig. 1 shows the main parts of a simplified single-cylinder single-acting air compressor with zero clearance. A flywheel receives energy in the form of mechanical shaft work through the rotating shaft on which it mounts. Through the connecting rod it moves the piston inside the cylinder back and forth through intake and compression-discharge strokes.

At each end of the strokes the piston comes to a dead stop, though the flywheel rotates at a continuous rate. Fig. 1*f* shows that piston speed accelerates rapidly until it reaches maximum velocity at midstroke when it starts decelerating for the last half of the stroke. These rapid accelerations and decelerations make it necessary to use a flywheel. Rapid change in rate of energy transmission to the piston puts a varying load on the driving engine or motor supplying the shaft energy input. The flywheel stores considerable energy as rotating kinetic energy. By drawing on and replenishing this energy as needed during one revolution the instantaneous fluctuations in shaft speed become smaller.

In Fig. 1*a* the piston stands at the head end of its stroke with the intake valve open to atmosphere ready to admit "free" air. In *b* the piston moves at its highest speed toward the crank end while free air enters through the inlet valve to fill the cylinder.

In *c* the piston stands at the crank end of its stroke. The inlet valve has just closed and the cylinder is filled with free air (at atmospheric pressure). In *d* the piston moves at its highest speed toward the head end compressing the entrapped air into a diminishing volume and raising its pressure. When the air pressure rises to the rated discharge pressure, the outlet valve automatically opens and the pressurized air begins to discharge to the compressed-air system. In *e* the piston stands again at the head end of the cylinder and has just finished discharging the last of the pressurized air. The outlet valve closes while the inlet valve opens and we are ready for the next cycle as in *a*.

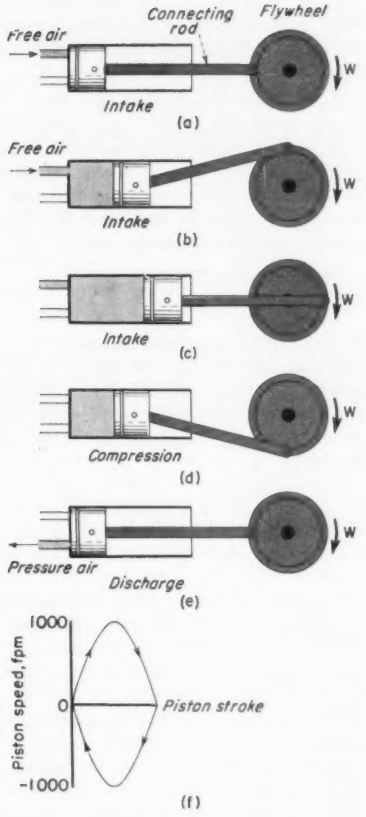
Air processes. From Fig. 1 we see that the flywheel through the connecting rod moves the piston back and forth. In Fig. 2 we study what the piston does on the air being compressed. Again we use P-V co-ordinates to analyze the actions of the gas in the cylinder, but this time the chart does not picture a complete thermodynamic cycle. In the latter the processes of the cycle always refer to one lb of the working fluid. In Fig. 2 we'll find that only one true process occurs in the cylinder during which the mass of air in the cylinder stays constant.

In Fig. 2*a* the piston moves from V_1 to V_2. Atmospheric air enters the cylinder through the inlet valve to fill the displacement volume swept out by the piston. During this induction stroke we assume the entering free air presses on the piston with atmospheric pressure $P_1 = P_2$. But this represents a force acting through a distance, so the air does mechanical work on the piston:

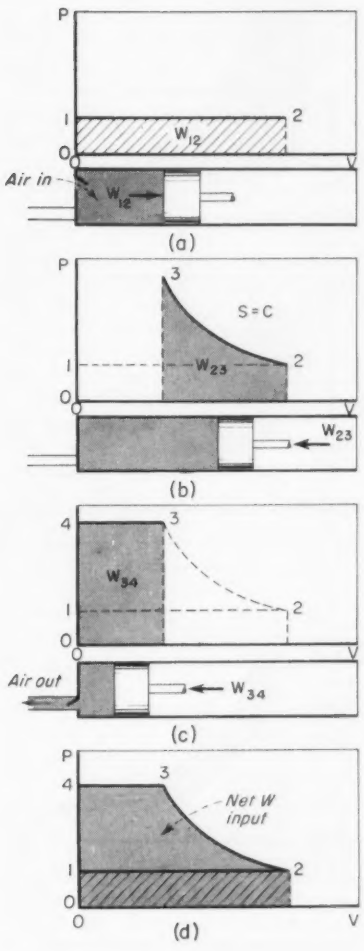
$$W_{12} = P_2(V_2 - V_1) = P_2V_2$$

since $V_1 = 0$ with a zero-clearance compressor as we have here.

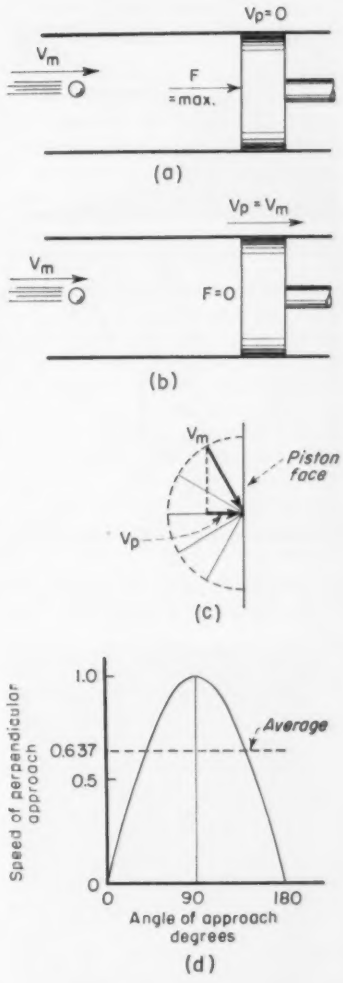
Note particularly that we did *not* say the entering air during the induction stroke moved the piston. The connecting rod supplied the force to move the piston, the air merely added a small contributing force. In so far as the air did work, it gave up energy to the piston. In this study we are interested



1 Reciprocating compressors take mechanical work from rotating flywheel to pressurize air in cylinder with piston



2 Pressure variations, plotted on P-V graph, of air in cylinder measures amount of work done on air by piston



3 Molecular study shows air pressure on moving piston differs from pressure exerted on a stationary piston

only in what happens to the free air.

At V_2 the inlet air valve closes. Then, during the first part of the return stroke we have a true process with a constant mass of air being compressed at constant entropy from V_2 to V_3 as in Fig. 2*b*. The area under the process curve then measures the mechanical work done on the air by the piston in pressurizing it to P_3, or:

$$W_{23} = \frac{P_3V_3 - P_2V_2}{1-k} \qquad \text{(A)}$$

See Part 8, May 1957, p 107-108, for the basic equation of work done by a reversible adiabatic (constant-S) process. When the process expands a gas from a higher to a lower temperature, equation (A) gives us a positive number for the work done, W. But, when the process compresses the gas from a lower to a higher temperature as we do here, the equation gives us a negative number for the work, W. Don't let this confuse you; this simply means that the work is done *on* the gas, not by the gas. Always keep this in mind when combining equations for several processes as we'll do in a little while.

Notice that in writing the equation, whether for compression or expansion, the quantities for the initial state are subtracted from the quantities for the final state of the process. When written this way the positive and negative answers immediately show whether work has been done by the gas or on the gas.

In an actual compressor we usually know P_2, P_3 and V_2, but not V_3. To use this equation easily we have to eliminate V_3. We do this by remembering that for an isentropic compression (see Part 8, p 108):

$$\frac{T_3}{T_2} = \left(\frac{P_3}{P_2}\right)^{\frac{k-1}{k}} \qquad \text{(B)}$$

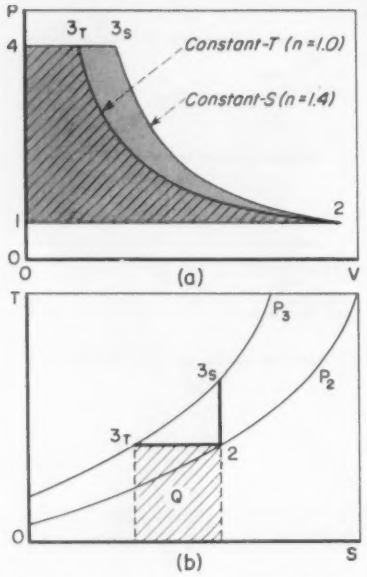
By multiplying equation (A) by P_2V_2/P_2V_2 we get:

$$W_{23} = \frac{P_2V_2}{1-k}\left(\frac{P_3V_3}{P_2V_2} - 1\right)$$

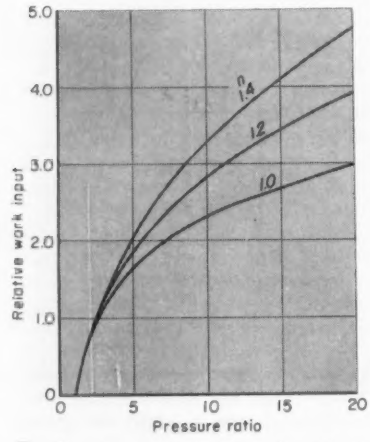
Then using Boyle's law, $PV = RT$ we change the equation to:

$$W_{23} = \frac{P_2V_2}{1-k}\left(\frac{RT_3}{RT_2} - 1\right)$$

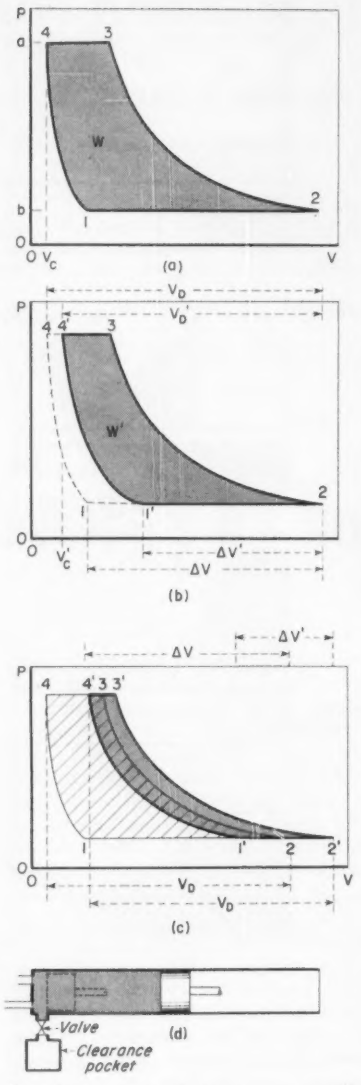
(*Continued on page* 114)



4 Compressor using constant-*T* process needs least total work input



5 Compressor work input depends on both compression process and the pressure ratio but not on inlet air pressure



6 Air flow through compressor usually is controlled by varying the clearance volume needed, for practical reasons

Cancelling R's and substituting from equation (B) we have:

$$W_{23} = \frac{P_2V_2}{1-k}\left[\left(\frac{P_3}{P_2}\right)^{\frac{k-1}{k}} - 1\right] \quad (C)$$

This looks complicated, but as soon as we make numerical substitutions the equation solves easily.

In Fig. 2*c* when the pressure reaches P_3 the discharge valve automatically opens and as the piston continues moving to the left it forces the pressurized air out of the cylinder into the pressurized system at P_3.

During the discharge stroke we again assume the air pressure stays constant, this time at $P_3 = P_4$. The discharge air impresses a resisting force on the piston and makes it do work W_{34} on the air. The piston transfers this energy to the air by mechanical work which equals:

$W_{34} = P_3(V_3 - V_4) = P_3V_3$

since $V_4 = 0$. At V_4 the discharge valve closes and the inlet valve opens as in *a* to repeat the cycle for the next revolution of the flywheel.

In Fig. 2*d* we put all the cylinder events on a common chart. The gray areas represent work done on the air by the piston, V_2 to V_4. The hatched area under *1-2* represents work done by the air on the piston. So the difference in areas, *1-2-3-4*, measures net work done by the piston in compressing the air from P_2 to P_3. In equation form this works out to:

$W = W_{23} - W_{34} + W_{12}$

$$W = \frac{P_3V_3 - P_2V_2}{(1-k)} - P_3V_3 + P_2V_2$$

remembering minus means work done on the gas, plus is work done by the gas. Combining terms we get:

$$W = \frac{k(P_3V_3 - P_2V_2)}{(1-k)} \quad (D)$$

This equation parallels equation (A), differing only by the constant k in the numerator. Since (A) was transformed into equation (C) we can immediately write a parallel equation for (D) in the form:

$$W = \frac{kP_2V_2}{1-k}\left[\left(\frac{P_3}{P_2}\right)^{\frac{k-1}{k}} - 1\right] \quad (E)$$

This evaluates the net work done on the air by an ideal zero-clearance compressor as in Fig. 2*d*, when the compression is done at constant entropy, that is, as a reversible adiabatic. To use this equation for a reversible polytropic compression simply substitute n for k. Mechanical work done on the air figured by all these equations will be in ft-lb; to convert to Btu simply divide by $J = 778$.

Intake and discharge. Let's take a closer look at the intake stroke *1-2* in Fig. 2. We make the simplifying assumption that the incoming free air acts with constant pressure on the moving piston. If we accept the molecular kinetic theory of gases this cannot be true.

Air pressure on the piston varies with the piston speed. In Fig. 3*a* with zero piston speed v_p the pressure or force acting on the piston is a maximum. This pressure is produced by gas molecules approaching the piston with a speed v_m and rebounding with an equal but opposite speed.

But suppose the piston was moving with the same speed as the molecules so $v_p = v_m$, then the molecules could not catch up with the piston and there would not be any pressure on the piston because of no impact.

From Part 6, Feb 1957, p 89, we learned that the pressure or force was:

$F = 2mv/t$

where v is the speed of the molecule *relative to* the wall or the piston.

Let's estimate the extent of the error caused by assuming constant pressure during intake. At 60 F, air molecules have an average speed of about 90,000 fpm. But, as shown in Fig. 3*c*, molecules can approach any one point on the piston face through an angle varying from 0 to 180 degrees. But, as we learned in Part 6, it's only the component of the motion perpendicular to the face that produces force or pressure. So for v_m, only v_p produces pressure. Any one point is struck by billions of molecules coming from all directions in one second.

We then can assume a distribution curve of pressure-producing velocities at one point as shown in Fig. 3*d*. This is a sine curve, the average of a sine curve is 0.637 of the maximum value. So, for an air molecule speed of 90,000 fpm, the average pressure-producing velocity will be about $90{,}000 \times 0.637 = 57{,}000$ fpm. Recognizing m and t as constants, the relative force produced by 60-F air molecules $= 2 \times 57{,}000 = 114{,}000$ units on a stationary wall or piston.

The average piston speed of a high-speed air compressor runs about 700 fpm. For such a unit the relative speed of approach of a molecule to the piston would be $57{,}000 - 700 = 56{,}300$ fpm. The corresponding relative force on the piston is then $2 \times 56{,}300 = 112{,}600$ units. For this case then, the actual pressure can only be $112{,}600/114{,}000 = 0.988$ of the atmospheric pressure; or the error is about 1.2%. The slower the piston speed, the smaller the error.

On the other hand, the energy of the air molecules depends on the square of the velocities. Before impact the molecules have an internal energy of about $57{,}000^2 = 32.5 \times 10^8$ units.

After impact the absolute velocity of the molecules drop to $57{,}000 - 2 \times 700 = 55{,}600$ fpm. Their internal energy after impact is then $55{,}600^2 = 30.9 \times 10^8$ units. Internal energy of the entering air then drops on the order of $30.9/32.5 = 0.951$ or 95.1% of the atmospheric air. The error in assuming constant internal energy of the air is of the order of 4.9%.

In the reverse stroke of discharge in process *3-4* of Fig. 2, the pressure can't stay constant either as we assumed. Here the piston approaches the advancing molecules and speeds them up more than if the piston was stationary. This raises both the pressure and the internal energy of the discharging air. When we study actions in an actual compressor we'll find that the air pressure during intake is lower, and during discharge higher, than we assume. The molecular study we just made shows why. For many design problems the constant-pressure assumption is good enough for our needs because it simplifies calculations.

Constant-*T* compressor. In most compressed-air systems no effort is made to conserve the internal energy of the air. By the time it reaches its point of use the air has cooled down to atmospheric temperature. This condition makes it practical to use a constant-*T* instead of a constant-*S* compression process. Fig. 4*a* shows how the two compressors compare. The area of the constant-*T* compressor is smaller than the constant-*S* compressor area. We can get the same amount of pressurized air for less work input, a desirable gain in economy.

Net work input for the constant-*T* compressor is:

$$\mathbb{W} = P_3V_3 + P_2V_2 \log_e(P_3/P_2) - P_2V_2$$

The first and last terms are the discharge and intake works, the middle term is the work of constant-*T* compression (see Part 8, May 1957, p 107).

Since $P_3V_3 = P_2V_2$ when $T_3 = T_2$ the net work of a constant-*T* compressor is:

$$\mathbb{W} = P_2V_2 \log_e(P_3/P_2) \qquad \text{(F)}$$

This is in ft-lb for an ideal compressor with zero clearance.

Fig. 4*b* shows the comparable processes on T-S co-ordinates. It's impossible to show the intake and discharge strokes on these co-ordinates. The constant-*S* process *2-3*$_s$ is vertical and so involves zero heat transfer. On the other hand the constant-*T* process *2-3*$_T$ involves the transfer of heat Q from the air during compression. And, since the internal energy of the air does not change, the heat transferred $Q = \mathbb{W}$ the net work input to the compressor.

Actual compressors usually run with a polytropic process intermediate to the two shown in Fig. 4*b*. The process line would end on P_3 somewhere between *3*$_s$ and *3*$_T$. For a reversible process, the area under the curve measures the heat transferred during the compression which differs from total work.

Work inputs. Equations (E) and (F) give us the works for the two extremes of heat transfer during compression. We can figure intermediate $\mathbb{W}$'s by substituting n for k in (E). For a compressor with fixed P_2 and V_2 working on air, $\mathbb{W}$ depends solely on the pressure ratio P_3/P_2. Assuming P_2V_2 equals one, we can study how $\mathbb{W}$ varies with pressure ratio as in Fig. 5, for different values of n. When $n = k = 1.4$ we have constant-*S* compression. When $n = 1.0$ we have constant-*T* compression; for intermediate values we have a polytropic compression. Fig. 5 shows that work input rises at a decreasing rate as the pressure ratio increases.

To get work input in ft-lb from Fig. 5 we need only to multiply the relative work input by the product P_2V_2 remembering that P must be in psf and V in cu ft per lb. Notice that P_2 can be any pressure, it's not limited to atmospheric.

Compressor clearance. The zero clearance compressor of Fig. 1 is only a simplified ideal. Practically it would be difficult to build a compressor without clearance and not have trouble from mechanical collision of cylinder head and piston. Other practical needs, as room for valves and ports, make it essential to provide clearance volume at end of compression-discharge stroke.

Fig. 6*a* shows the actions in an ideal compressor with clearance. At *2* the cylinder is filled with air at atmospheric pressure. From *2* to *3* the entrapped air is compressed at any desired process. At *3* the discharge valve automatically opens, and from *3* to *4* the pressurized air leaves the cylinder to enter the compressed-air system. At *4* the discharge valve closes and the pressurized clearance air expands as the piston moves to the right towards *1*.

When the clearance air pressure drops to P_1 of the free air, the inlet valve automatically opens. Then from *1* to *2* free air flows into the cylinder as the piston recedes to its crank-end position, and the cycle repeats.

The area under *2-3-4* measures the work done on the air by the piston. Area under *4-1-2* measures the work done on the piston by the air. Difference of these areas, *1-2-3-4*, shown in gray, measures the net work $\mathbb{W}$ done on the air by the compressor. How do we calculate this work?

By studying Fig. 6*a* we see that $\mathbb{W}$ is the difference of two zero-clearance cycles, *a-b-2-3* and *a-b-1-4*. Using the polytropic form of equation (E):

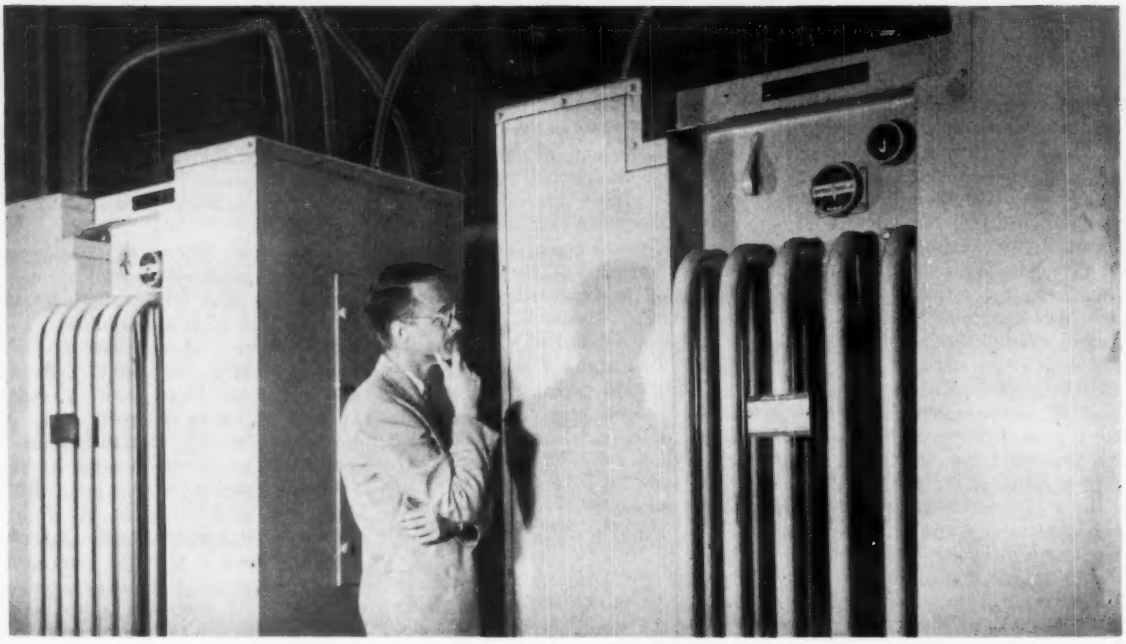
$$\mathbb{W} = \frac{nP_2V_2}{1-n}\left[\left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} - 1\right] - \frac{nP_1V_1}{1-n}\left[\left(\frac{P_4}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

Since $P_2 = P_1$ and $P_4 = P_3$ we can clear the equation to the form:

$$\mathbb{W} = \frac{nP_2(V_2 - V_1)}{1-n}\left[\left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} - 1\right]$$

The only difference between this equation and (E) is that the volume used

(*Continued on page* 220)



When talking transformers, there's more to color than meets the eye: Example . . .

Does color <u>really</u> affect transformer temperature?

► POWER SERVICE ENGINEERS often raise the question of color and its effect on transformer cooling. This may pop up when ordering new transformers or in making a decision to repaint existing units.

The facts, briefly, are as follows: Transformers located outdoors and exposed to the sun should be repainted after considering durability and appearance rather than heating matters. Actually, any heat-transfer improvement resulting from use of special paint is mighty small. Example: Using a white-lead paint on a smooth tank, the temperature advantage would run only a few degrees even on a hot sunny day.

If transformers are spotted out of the sun, temperature rise using nonmetallic paint is practically independent of color. Actually, metallic paints radiate less heat than nonmetallic, hence could cause a transformer to overheat. As pointed out in the *Standard Handbook for Electrical Engineers,* a plain aluminum-painted tank will run about 30% hotter than one painted with a nonmetallic finish. The winding rise over room temperature will go up the same number of degrees as the oil rise.

Incidentally, that 30% figure represents about the maximum you can get through painting with aluminum rather than a nonmetallic paint. However, if a transformer were finished with a material such as polished nickel, silver, etc, the temperature increase might skyrocket to 75%. As tank convolutions increase, the effect of metallic paint decreases.

The figures above are supported by the basic laws of heat transfer. Remember, those colors which reduce heat radiation also have the property of reducing heat absorbtion from sun's rays, though not always to the same extent. For example, the low-temperature total emissivity of green paint is 0.95 while the coefficient of absorbtion for solar radiation with light green paint is 0.50. But the emissivity and absorbtion powers for aluminum paint are equal.

Many might think that a transformer painted a light color would operate at a lower temperature out in the sun than if painted black. Such an impression is based on the relative absorbtion powers of the colors *where no internal heat must be thrown off.*

Naturally, transformer temperature rise over the cooling surrounding air of any transformer will be greater when operated in the sun than in the shade. The difference in temperature rise hinges on how long the sun shines and how strong it is in any 24-hr period. There are other factors such as the ratio of the developed to the enveloped area of the transformer, percentage of tank area exposed to the sun, and ratio of the thermal capacity of the oil and materials to the effective radiating surface.

When repainting, remember that it's the final coat that determines the effective emissivity value.

Pumped storage hydroelectric units applied under low and high heads

► HYDRO PLANTS with water storage capacity have specific economic advantages when operated on large power systems. Where sufficient storage is not available under natural conditions, extra capacity may be obtained by pumping into elevated reservoirs to provide standby and peak-load capacity or seasonal storage. Most pumped-storage plants have been installed in continental Europe but idea is now finding favor in other lands for both low- and high-head installations.

Siphon setting. Recently Canadian-Brazilian Services, purchasing agent for the São Paulo Light S.A.—Services de Electricidad, ordered from S Morgan Smith Co a kaplan adjustable-blade axial-flow reversible pump-turbine. Unit will be installed in a vertical siphon setting in the Traicao pumping plant near São Paulo, Brazil, where it will supplement two identical pump-turbines to help meet increased power demands in the São Paulo area.

No. 1 unit in the plant, built in 1938, was the first reversible pump-turbine installed in the Western Hemisphere. Original design of these units was developed on the company's pump-turbine testing stand in its hydraulic laboratory at York, Pa.

Traicao pumping plant on the Pinheiros Canal is one of a series of low-head pumping plants connecting the Tiete River with the Billings Reservoir. This reservoir supplies water to the high-head (2263-ft) Cubatao power plant at the base of the coastal cliffs near Santos.

Rated capacity. The pump-turbine has a 138-in. diameter runner, will operate under a net head of 10 to 23 ft. It connects directly to a 6600-hp motor-generator; is guaranteed to pump 1765 cfs (800,000 gpm) against a 23-ft head and generate 3450 hp under the same head.

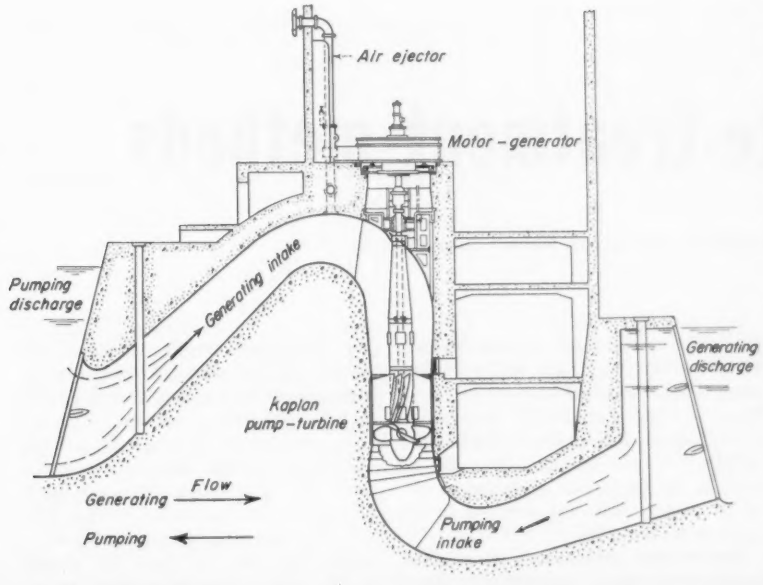
During low-water periods in the Tiete River, water must be released from the Billings Reservoir for irrigation and municipal purposes. Then pump-turbine operates in reverse direction and generates power. When unit is not required as a pump or turbine, water can be depressed down below the runner with compressed air and unit operated as a synchronous condenser to improve power-system power factor. Because of siphon-setting installation, before unit can operate on the power-generating cycle siphon must be evacuated to fill it with water before turbine is started. Normally it will not be necessary to evacuate siphon during pumping, except to free top of siphon of air.

First reversible centrifugal pump-turbine in the Western Hemisphere was installed by Canadian and General Finance Co in the Pedreira plant in Brazil. Plant is another of the low-head pumping installations in the series that supplies the Billings Reservoir.

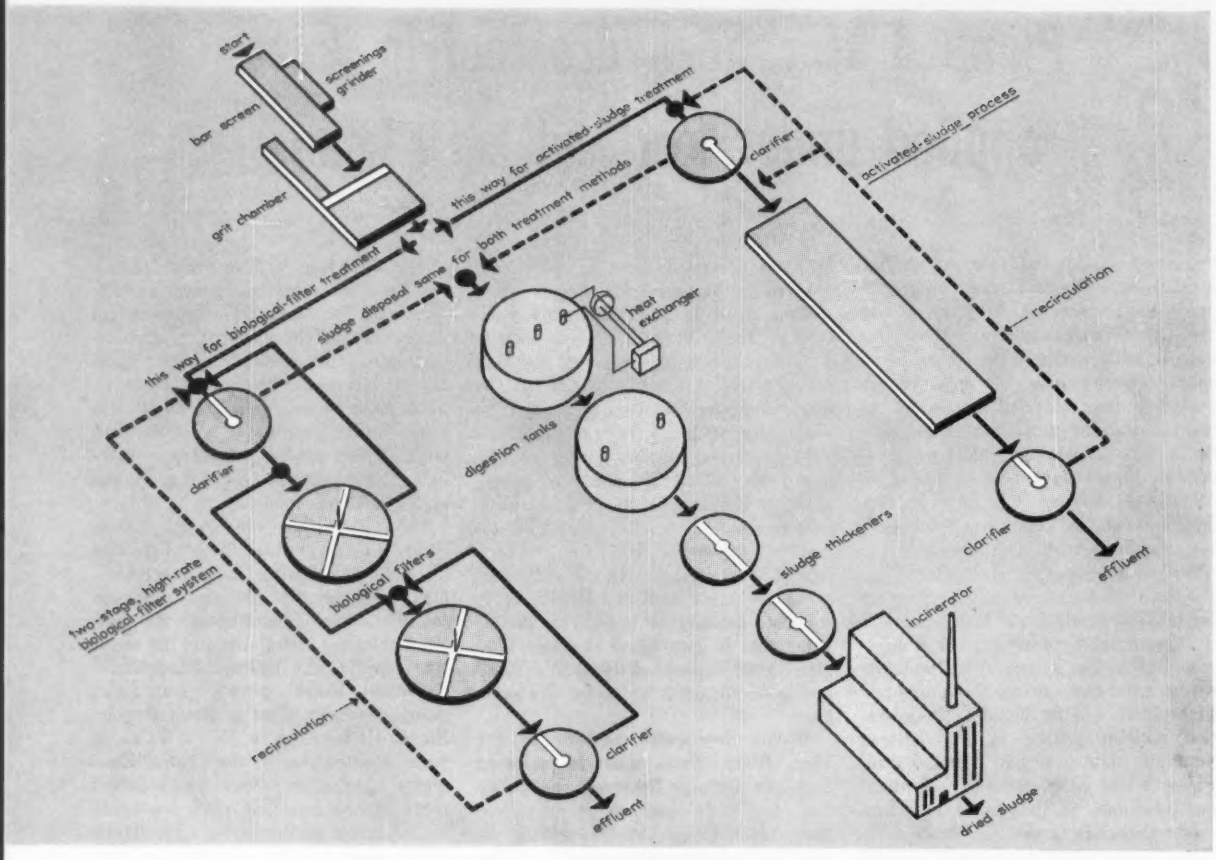
British hydro plants. Largest pumped-storage plant in Great Britain, Blaenau Ffestiniog in North Wales, is under construction by the Central Electricity Authority. Four vertical-shaft units will be installed, each consisting of a motor-generator, a 105,000-hp 970-ft head English Electric Co francis turbine and a 2-stage double-flow Sulzer Brothers 428-rpm pump. Each pump will discharge 745 cfs (335,000 gpm) against a 1000-ft head and 94,600-hp input. Maximum power input to the pumps will be about 110,000 hp, making them highest powered in the world in operation or under construction.

Ffestiniog is the first large plant of this type in Britain. It will be used to supply peak power demands during the day; at night off-peak power will drive pumps to lift water from lower level into a high-level storage reservoir. This plant is scheduled for 1961 operation.

Northern Scotland. Britain has also announced plans for a large pumped-storage hydro development—a $70,000,000 project in Northern Scotland. This includes installed capacity of about 600,000 hp in three plants: Cruachan, Inverawe and Nant on the Awe River. The Cruachan plant will be the first large pumped-storage plant in Scotland. Installed capacity will exceed 500,000 hp. Nights and weekends the plant will use off-peak power from steam plants to pump water from Lock Awe into a high-level storage reservoir against a 1300-ft head. Inverawe plant will have an installed capacity of about 50,000 hp, Nant will have 25,000 hp.



VERTICAL CROSS SECTION through a 6600-hp kaplan pump-turbine of type ordered for Traicao pumping plant near Sao Paulo, Brazil. Heads range from 10 to 23 ft



Biological treatment is most efficient for organic wastes, but newer ion-exchange systems are best for some inorganic wastes. Here's how to use both the old and new techniques that make up . . .

Today's waste-treatment methods

By T L MOORE, *Chief Sanitary Engineer, Gibbs & Hill, Inc*

► MANY VARIABLES must be controlled to do a good job of treating an industrial waste. Methods selected must handle the quantities involved economically and satisfy waste-disposal standards. As outlined last month, complete pilot-plant studies are needed to evaluate today's equipment and treatment processes. Final installment of this 2-part article will explain how to use both old and new methods for treating typical organic and inorganic wastes.

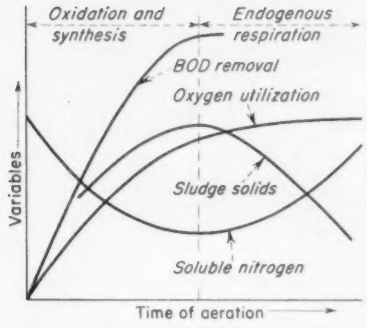
Biological treatment is lowest in cost and most efficient for organic wastes. Until recently, the exact theory of this process was somewhat of a mystery. Plant design was based mainly on empirical methods. But known bacteriological concepts can be used to explain the biological oxidation of organic wastes. This has resulted in its much wider use.

Biochemical oxidation of organic matter with living organisms is done by (1) passing organic wastes through a stationary biological bed or (2) passing biological growths through the wastes. Much data is available on biological-oxidation theory and its use in industrial-waste treatment.

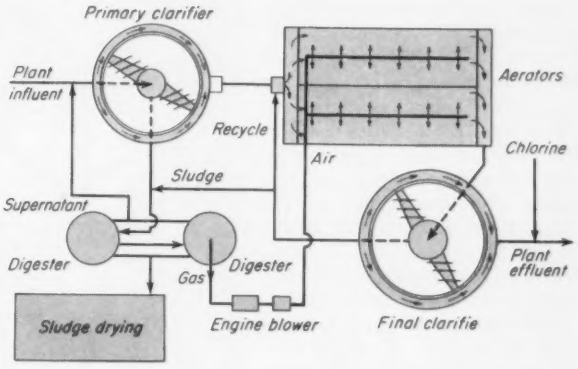
In an aerobic biological process, oxidizable organic matter is removed from the waste stream by enzymatic reaction with active biological floc. This floc is composed largely of micro-organisms such as bacteria, yeasts, molds, algae, protozoa, rotifers, worms and insect larvae in a gelatinous matrix.

Rate of organic-matter removal de-

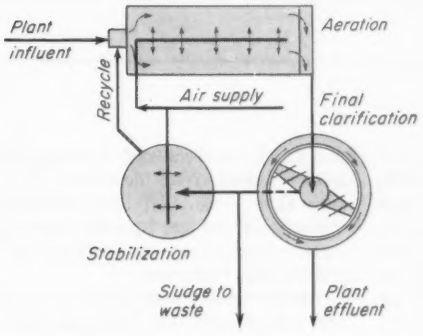
Much wider use is in store for the activated-sludge process



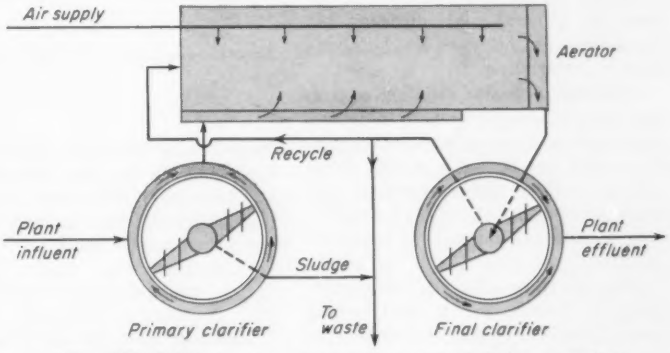
BIOLOGICAL OXIDATION removes organic matter by (1) oxidation (2) synthesis to new biological cells and (3) auto-oxidation (endogenous respiration) of the resulting sludge



ACTIVATED SLUDGE is an aerobic process. Incoming waste is mixed continuously with microbial sludge. Oxidizable organic matter is removed or stabilized by contact with slimes of living organisms. Part of resulting sludge is recycled to aerator



CONTACT STABILIZATION unit produces an activated biological floc from sludge. When mixed with incoming raw waste in aerator it helps absorb colloidal or oxidizable matter



STEP AERATION is one of several activated-sludge variations developed to increase flow rate and shorten detention time. Recycled sludge from final clarifier is fed in steps to the aerator. BOD removal from domestic sewage will run about 98%

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pends on the diffusion of essential food into the cells. Some organic matter is synthesized to form new biological cells. The remainder is oxidized, giving energy to sustain life and permit synthesis. Curves, above, show some of variables involved in the biological oxidation process.

The reactions include:

Oxidation

$$\text{Organic} + O_2 \xrightarrow{\text{enzyme}} Co_2 + H_2O$$

Cell synthesis

$$\text{Organic} + NH_3 + O_2 \xrightarrow{\text{enzyme}} \text{new cells} + CO_2 + H_2O$$

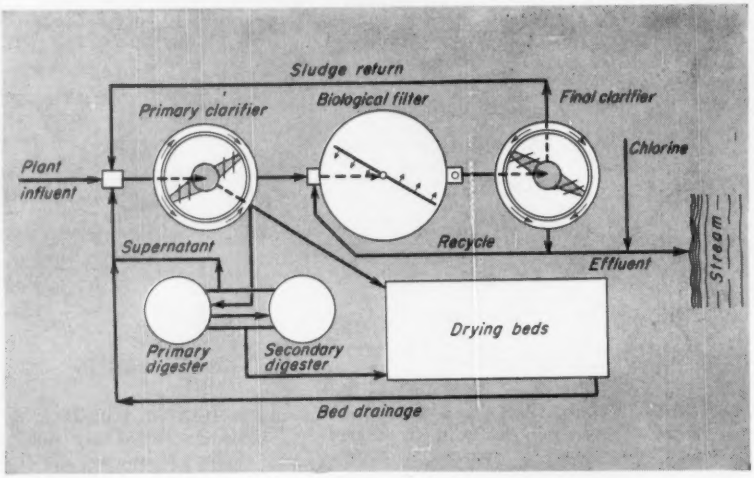
Endogenous respiration
(continuous auto-oxidation)

$$\text{Cells} + O_2 \xrightarrow{\text{enzyme}} Co_2 + H_2O + NH_3$$

Conventional activated sludge is an aerobic process. Incoming waste is continuously mixed with microbial sludge. The organic matter is removed or stabilized by this contact with the slimes of living organisms.

First, raw waste enters a primary clarifier. Then, settled effluent enters the aerator for mixing with biologically active sludge already produced by the process. Air under pressure is used for agitation and mixing. There is more than enough oxygen present to promote the growth of bacteria and other organisms. Mixture then enters a final clarifier. Bulk of the resulting sludge is accumulated in final settling

Biological filters actually absorb organics



BIO-FILTERS commonly called "trickling filters," contain inert filter media. Organic waste passing through the filter forms a gelatinous film of microorganisms on the media surface. These growths absorb any oxidizable organics. End products of this biological oxidation are carried away by the waste flow down through the filter bed

tanks for digestion or dewatering without digestion. Remaining sludge is recycled to aerator's inlet.

Contact stabilization process uses an aerated stabilizer tank to make an activated-sludge floc. It is often used to absorb colloidal or dissolved oxidizable matter in the waste stream.

Incoming raw waste is mixed with the activated floc in the aerator tank. The mixture is then sent to a clarifier for separation of activated sludge from the waste. Clarifier effluent is usually good enough for stream discharge. Part of settled sludge from the clarifier is sent to the contact stabilization tank. Air fed into the unit supports oxidation and synthesis of absorbed organics. Two to three hours' detention time is usually sufficient. Activated floc from the stabilizer tank is then sent to the aerator for continuous mixing with incoming raw waste.

Excess sludge is drawn off and disposed by (1) anaerobic digestion (2) dewatering (3) filtration or (4) drying beds or incineration.

Modified activated-sludge systems have been developed by both individual engineers and manufacturers to increase the flow rate and shorten detention time. These design variations take three distinct forms: (1) step aeration, (2) modified aeration (3) activated aeration.

Step aeration adds recycled sludge from the final clarifier to the incoming raw waste at various points in the aerator. This gives different suspended-solid concentrations throughout the aerator tank. BOD removal from domestic sewage runs about 98%.

Modified aeration setup is similar to conventional activated sludge, but solids concentrations in the aerator are lower and sludge age is considerably less. Removal efficiencies are better than efficiencies from primary sedimentation and not as good as those from an activated-sludge plant. BOD removal from domestic sewage is about 68% in plants of this type.

Activated aeration equipment operates in parallel with full activated sludge. Excess sludge is taken from the activated sludge tanks. It is then added to the head end of a second group of tanks and aerated with waste. Remaining excess sludge from both tanks is removed and concentrated. BOD removal from domestic sewage runs about 76%. All these variations use less air and get by with somewhat smaller tanks than conventional activated sludge equipment.

Aeration equipment plays an important role in all of the biological waste-treatment processes covered thus far. Liquid-sludge waste mass must absorb enough oxygen from the aerating gas to sustain the biological reactions.

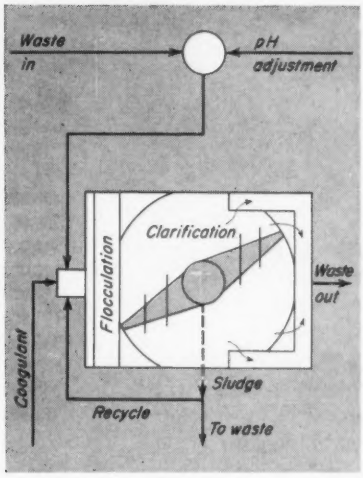
Rate of solution of the gas varies with the area of gas-liquid surface, system temperature, liquid and gas con-

Some typical results from biological-oxidation treatment

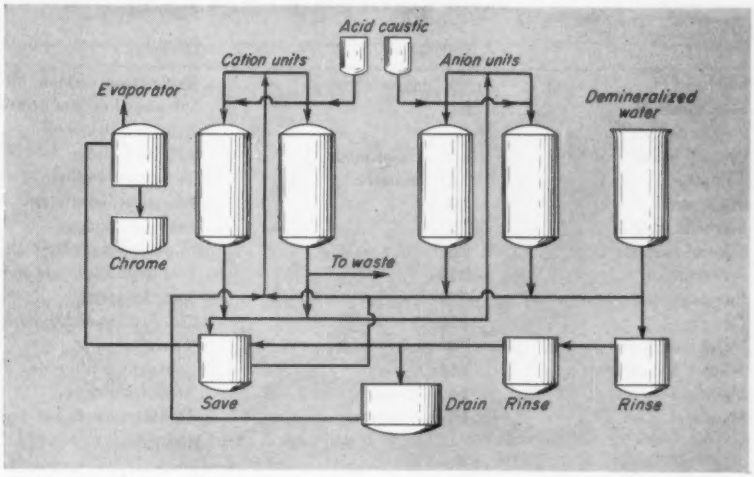
Activated sludge plants	BOD loading lb/day/lb MLSS	BOD raw, ppm	MLSS, ppm	Aeration detention, hr	% BOD removal
Sewage	0.22	153	2050	6.3	90
Pulp and paper	0.30	183	2910	3.8	91
Pharmaceutical	1.60	1556	3292	3.7	89
Cannery	2.56	630	2500	4.8	81
Packing house	1.36	960	3500	2.5	88
Oil refinery	0.18	200	2000	7.0	92
Kraft mill	0.48	144	900	8.0	85
Ammonia still	0.13	100	2530	5.0	93
Pulp and paper	0.57	600	4200	3.1	93

Biological filter plants	Filter depth, ft	Applied BOD, ppm	Hydraulic loading, mgad	Recirculation ratio	Loading lb BOD, yd^3	% BOD removal
Sewage	4.4	184	16.0	1.86	1.22	83.4
Pharmaceutical	4.0	3110	15.0-20.0	10-23	3.34	56.0
Pharmaceutical	6.0	3500	54	12	1.2	66.0
Pharmaceutical	6.0	4100	78	18	1.6	78.0
Kraft mill	6.0	117	52.0	2.4	4.4	27.0
Straw board	6.0	820	17.0	10.0	1.24	54.0
Dairy	4.0	1160	15.0	13.5	1.42	92.0
Distillery	8.0	675	25.0	3-5	1.97	60.0
Distillery	6.0	700	6.4	4	0.75	93.0
Chemical	6.0	1800	4.4	10	0.63	94.0
Chemical	6.0	2200	7.2	10	1.30	65.0

Both old and new methods team up to handle inorganic wastes



CHEMICAL TREATMENT plays a big role. Coagulation and precipitation help to remove colloidal suspensoids. Waste pH can be altered to reduce scale, corrosion



ION EXCHANGE SYSTEMS recover valuable chromate from the metal-plating rinses. Evaporators concentrate it for re-use. Ion exchangers also produce enough demineralized water for plating rinse makeup. Problem of waste disposal created by toxic chromate is solved with byproduct recovery of chemical as a dividend

tact time, magnitude of driving force (concentration gradient) and intensity of agitation.

Aerator design and selection is based on the anticipated variations in oxygen-use rates. It also takes into account the oxygen transfer and agitation characteristics of the particular design.

Biological filters are often called "trickling filters." Oxidizable organic wastes are absorbed by microscopical biological growths adhering to an inert media in the filter.

The equipment is usually circular in structure and contains a bed of crushed stone or other media of variable depth. Incoming raw waste is distributed over the surface by rotary distributors or fixed nozzles. It trickles through the unit and is collected by an underdrain system.

Both standard- and high-rate filters are available. Both types have a media bed, underdrain and ventilation system and a means of distributing waste over the filter surface. Main difference is in the amount of filter loading on each.

Standard-rate filter has an organic loading less than 600 lb of BOD per acre foot of filter. Loading on high-rate filters can exceed 1600 lb. High-rate units are often set up in series for 2-stage operation.

Biological filter plants usually have primary settling equipment to remove all large suspended solids in the incoming waste. Pretreated organic waste is then passed over the filter forming a gelatinous film of microorganisms on the filter-media surface. This film consists of microbial cells in various stages of activity, organic matter in various stages of decomposition and oxidized and nonoxidizable organic and inorganic residues.

Colloids absorbed by the film are coagulated and hydrolized to smaller molecules. Soluble organics are diffused into the film and oxidized by enzymatic action. End products including CO_2, NO_3 and nonoxidizable organics are rejected by the film back into the waste, establishing dynamic oxidation equilibrium.

Amount of biologically active growth varies with temperature, organic loading to the filter, area dimensions of supporting film surface and hydraulic loading to the filter. Waste contact time with the microbial film is fixed by the downward percolation rate through the filter bed. This can be partially regulated by effluent recirculation and more uniform dosing.

Aerobic digestion stabilizes the sludge withdrawn from primary or final set-

Inorganic wastes take many forms

Waste water	Inorganic material
Steam generation	Water conditioning, boiler and condenser cooling sludges and dissolved solids
Steel pickling wastes	Free acids and acid salts
Phosphate fertilizer	Silicate salts
Coal mining and washing	Sulfates of Ca, Mg and Fe
Pulp and paper	Soda ash, sulfides, sulfates, and carbonates
Textiles	Free acids, caustics, sulfates and polysulfides
Explosives	Copper, zinc; sulfuric, nitric and picric acids
Petroleum	Brine, chlorides; sulfates, acids and alkalies
Steel products, plating	Acids, alkalies; salts of cyanide, copper, chrome, etc
Radioactive	Fission products of uranium and plutonium in coolants

Cost and size of waste-treatment installations vary

Industry	Waste, mgd		Process	Dollar cost
Municipal	5.0	domestic	Single-stage trickling filter	630,000
Starch process	0.45	-	Submerged culture aeration	172,000
Pulp and paper	16	-	Activated sludge	2,000,000
Packing house	0.03	-meat products	Activated sludge	30,000
Turnpike	0.05	domestic	Two-stage bio-filter	74,000
Wallboard	2.0	-	Primary sedimentation	400,000
Synthetic fiber	2.0	-	Activated sludge	1,000,000
Mineral products	0.01	Pitch residue	In-plant changes and oil separators	15,000
Brewery	0.28	-	Two-stage bio-filters and digestion	225,000
Canning	0.70	-	Spray irrigation	251,000
Cannery	1.30	-	Clarification and digestion	181,000
Metal finishing	3.0	-	Varied	900,000
Brewery & domestic	0.54	-	Single-stage filters and digestion	665,000
Municipal	2.40	Domestic	Activated sludge	360,000
Municipal	1.20	Domestic	Oxidation ponds and digesters	191,800

tling tanks. Need for treatment depends on a variety of conditions including: disease producing possibilities, concentration of putrefactive organisms, appearance and odor. All domestic wastes usually need further stabilization of the resulting sludge.

Digestion by anaerobic fermentation converts hydrogen and carbon of organic sludge into carbon dioxide and methane gas leaving a stabilized residue suitable for disposal.

Rate of digestion is increased by heating with either an external source or combustible gas recovered from the process. Optimum digester temperature for maximum efficiency of bacterial action is 90 to 95 F.

Wastes that are high in BOD usually respond to anaerobic digestion. This includes waste produced by distilleries, canneries, tanneries, slaughterhouses, creameries and various fermentation and dehydration plants. Predigestion of waste is a good way to stabilize waste pH. It also reduces organic loading on activated-sludge units or biological filters included in today's biological waste-treatment plants.

Sludge digesters are usually constructed of concrete with either concrete or steel roofs and designed for single or 2-stage operation.

Sludge from clarifiers is pumped to the digester. First, consider a 2-stage design. The first-stage unit is heated to increase bacterial efficiency and agitated to prevent stratification. Organic material in the sludge is removed by anaerobic bacterial action.

Sludge is retained in the first stage for 15 to 20 days. Then it passes to the second-stage tank along with supernatant liquor and gas. The second stage doesn't need heating or agitation; it acts as a gas holder with solids, liquor and gas separation occurring very rapidly.

In a single-stage operation, complete digestion is carried out in one tank. Gas formed is collected in the tank dome. Actual selection of either system depends on sludge quantity and characteristics and whether or not the byproduct gas will be used.

INORGANIC WASTE

Methods of removing inorganic material from waste are quite varied. Liquid-solid separation by gravity is used for readily settleable material. Flotation is used for low-density solids. Substances in a colloidal form or otherwise not readily settleable can be separated from liquid with the aid of coagulants. Principles used in suspended-solids removal are quite similar for both organic and inorganic wastes. In all cases specific data must be obtained on the separation characteristics of the waste.

Sedimentation and flocculation is the removal of suspended and coagulated particles from a liquid medium having a lower density. The process is accelerated by gravity and resisted by drag. Amount of drag is influenced by viscosity (Stokes' law) and is related to Reynolds number. When the Reynolds number is high (turbulent settling), drag is relatively independent of viscosity. When it is low, viscosity is an important factor. Temperature is a major influence. Both turbulent and viscous settling occurs within the range and nature of the suspended solids encountered in many industrial wastes.

If suspended-solids concentration is high enough, settling paths of the particles may interfere and actually retard sedimentation. Free settling calls for a concentration of suspended solids less than 1000 ppm.

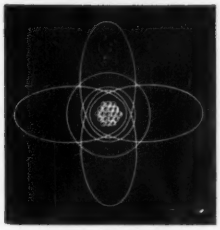
Settling velocities, computed from Newton's and Stokes' laws, pertain to discreet particles. But suspended solids in industrial wastes are usually flocculant in nature and are influenced by agglomeration that increases size and density, changes particle shape. This reorientation increases the settling rate of coalesced particles.

Chemical coagulation removes colloidal suspensoids by precipitation. Coagulating agents cause precipitation by reducing the electrical charges on colloidal particles to form positively charged floc for mutual coagulation. This floc enmeshes colloids in the waste. Some colloids with low exchange capacity are removed by agglomeration.

Both organic and inorganic wastes may require pH adjustment to reduce corrosion or scaling properties and otherwise properly condition the waste for treatment.

Many chemicals are available for precipitation. Their application varies with the waste constituents and physical condition. Aim of the treatment is to substitute less objectionable ions for the toxic compounds or other substances in the waste that are unsuited for specific water re-use. Resulting

(*Continued on page 222*)



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Radiation Effects Information Center has been established at Battelle Memorial Institute, Columbus, Ohio by the Air Force. It will gather and issue data on effects of nuclear radiation on materials and systems that may be needed for future aircraft. Data will be available through reports, memoranda, personal consultation and group meetings. Services will be available to Army, Navy, AEC and other government agencies and their contractors.

Yankee Atomic Electric Company has been issued a construction permit by the AEC to build a 134-mw PWR at Rowe, Mass. Permit is only provisional since reactor design has not been completed. Plant will cost about $57 million exclusive of research and development being furnished by AEC under Power Demonstration Reactor Program. Details of waste disposal and emergency procedures in case of accident will be reviewed before a final operating licence is issued.

Fuel cost reductions for cores of future pressurized-water reactors are expected according to W K Davis, director of reactor development, AEC. Savings anticipated over the initial Shippingport core during the next 10 to 15 years should be on the order of one-half for materials, three-fourths for fuel fabrication. Biggest economy boost is expected from extension of core life by eight times.

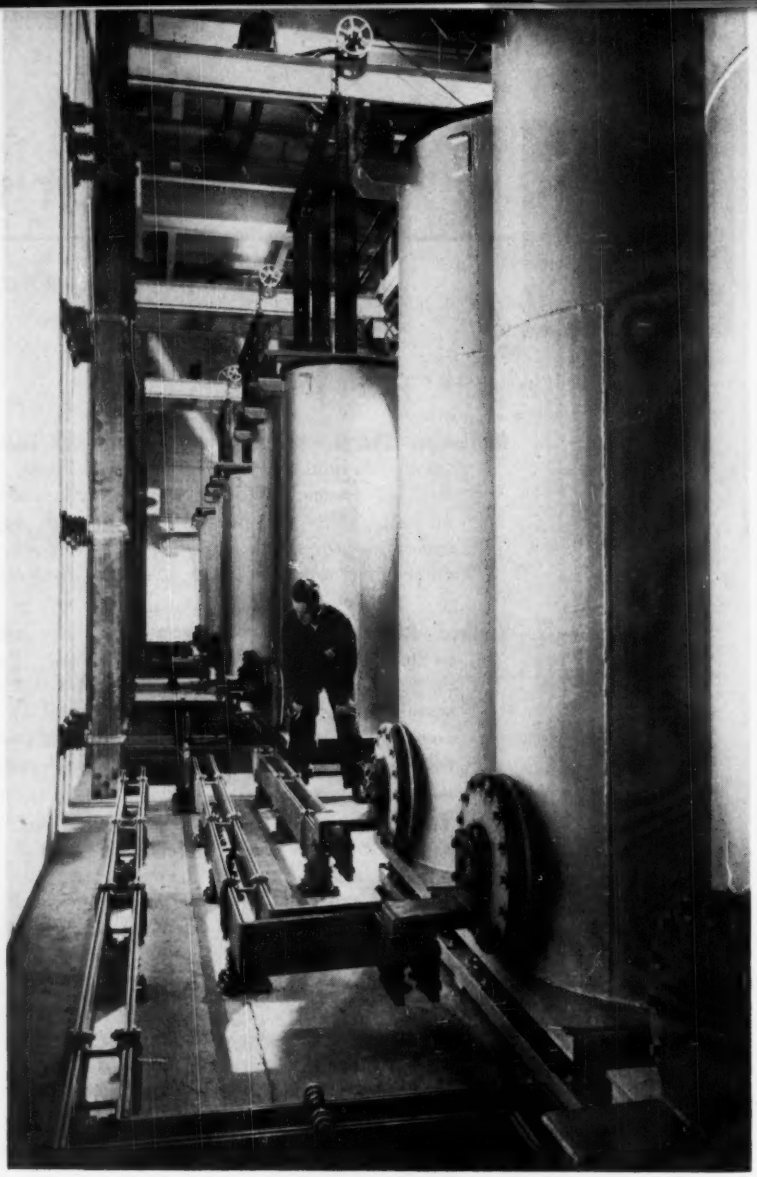
Ceramic fuel elements, such as oxides and carbides, can accommodate fission-product gases without swelling. Uranium oxide or mixed uranium thoride oxides seem to give good life, perhaps 25,000 megawatt-days per ton or more. They also have good neutron economy and conversion ratio. Disadvantages lie in low density and poor thermal conductivity of ceramics.

New Cambridge Electron Accelerator, to be run by Harvard and MIT for the AEC, started abuilding on Nov 4. This 6-billion electron volt synchrotron planned for 1960 initial operation will speed electrons to nearly the velocity of light. This swells the mass of the electron by 12,000 times. These electrons will smash protons and neutrons, aiding the study of the basic nature of matter and energy. The accelerator should produce heavy mesons, negative protons and new unstable particles in larger numbers.

Less government control, fewer restrictions now would help in earlier payoff of atomic energy, says L L Davenport, president, Sylvania-Corning Nuclear Corporation. He calls for: (1) reduction in uranium cost (2) standardization of reactor designs (3) reduction in high cost of security by relaxing regulations (4) more reasonable tolerances in design specifications (5) using the methods-engineering approach.

No takers in the chemical industry for private processing of spent fuel elements from research and power reactors has forced the AEC to agree to do this in their plants for the time being. High investment, waste-disposal problems and uncertain future business in this field scare off private processors.

Uranium producers have capital investment of nearly one billion dollars in mines and mills. Free World production in 1957 will be about 21,000 tons U_3O_8. In 1959 it is expected to run over 40,000 tons—more than 30,000 tons coming from U.S.A. and Canada. South Africa now produces about 6,000 tons annually.



3 OF 7 liquid rheostats for controlling a 250,000-hp load at Lewis Unitary Plan Activity Tunnel, Cleveland

By **E S AVERY**, *Industry Control Dept*
General Electric Co

With minimum wiring and few wearing parts, liquid rheostats are providing stepless control for some of today's biggest motors . . . and doing it economically

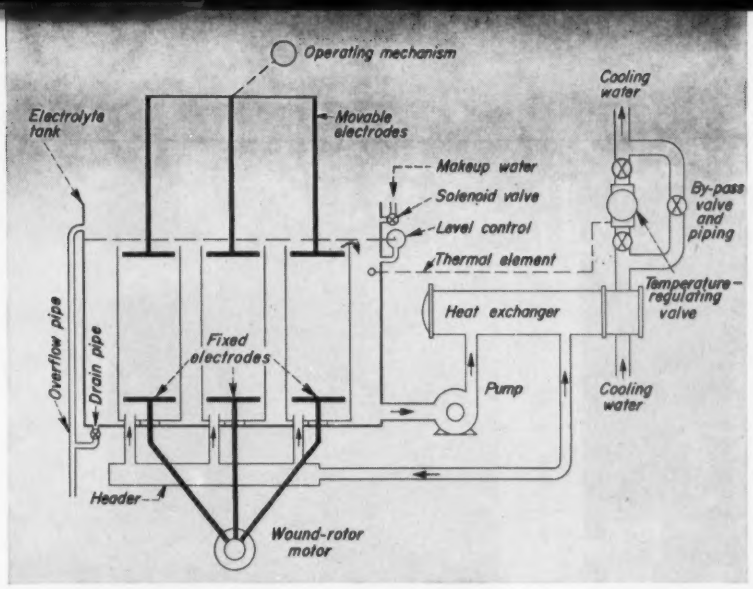
Liquid rheostats: An old-timer struts

► SLIP-RING wound-rotor motors in the 2500-hp range and up are being applied in growing numbers throughout industry. In tune with this trend is the growing interest in liquid rheostats as speed controllers. The rheostat with fluid innards serves as a variable resistance in the secondary circuit of wound-rotor induction motors. They also serve as adjustable loads for generator and engine testing.

Four types of liquid rheostat are *weir, vertical plate, round horizontal plate, square electrode. Weir* type, an early design, varied resistance by changing electrolyte level. Since a set of vertical plates served as electrodes, their submerged surface area and quantity of solution in the tank determined resistance between electrodes. A fast increase in resistance could be had by dropping a weir, letting the liquid run into a sump tank. Total resistance is trimmed by reversing the procedure; raising the weir and pumping solution back into the main tank. In some models cooling coils were mounted in sump tank to carry off heat.

Vertical plate rheostat uses stationary and movable electrodes pivoted at the upper corner. Movable electrode can be rotated to vary amount of surface exposed to the electrolyte. Since electrolyte resistance varies inversely as amount of contact area, resistance between electrodes is changed as they are moved in and out of electrolyte. Some of these rheostats are fitted with a weir for rapid lowering of electrolyte level.

Horizontal plate type has three horizontal electrodes mounted on tank bottom. Each electrode is surrounded by an insulating cell to electrically separate the phases. Three top or movable electrodes are suspended from an operating mechanism. They are tied together electrically and mechanically



PIPING SYSTEM for typical rheostat using external liquid-to-liquid heat exchanger. Latter can be designed to handle any load; can be built into a single packaged unit

Getting rid of the heat

How to efficiently dispose of the developed heat in a liquid rheostat has been a long-term problem. Through the years, various forms of cooling systems have been used. One of the early types used a simple set of coils immersed in the electrolyte. Cold water ran through these coils, hence the electrolyte was circulated thermally. Hot liquid rose until it came in contact with the cold coils. Here it would be cooled, drop to bottom of tank, drive out the hot electrolyte.

In another design, the hot electrolyte rose to small tanks where it was air cooled, then returned to the cells. In still another design the hot electrolyte was pumped into a large sump tank to be cooled, then pumped back into the main tank. Probably the most efficient cooling method is use of a liquid-to-liquid heat exchanger, above.

to tackle the big jobs

through long copper rods and bus bars, thus forming the wye connection. Resistance is varied by changing distance between stationary and movable electrodes. Connections are made with insulated studs passing clear through tank wall proper.

Square electrode design is simply a geometrical variation on the round electrode type. The square pattern provides more contact area for the same floor space taken up by the earlier round type. Holes drilled in plates allow for thermal or pumped circulation of electrolyte.

Electrode motion is generally handled by geared pilot motors operated through pushbutton or an automatic regulating system. Torque motors, hydraulic motors and air cylinders have been successfully incorporated into systems over the years.

Electrode material can be cast steel, cast bronze, iron, monel metal or a combination of nickel and steel. Electrolyte solution most widely used is sodium carbonate. Having a negative temperature coefficient, sodium carbonate is exceptionally good for cold starts since its resistance nearly doubles in passing from hot to cold. Sodium bicarbonate and sodium chromate have been used with steel electrodes while sodium carbonate has seen service with bronze or nickel-coated electrodes.

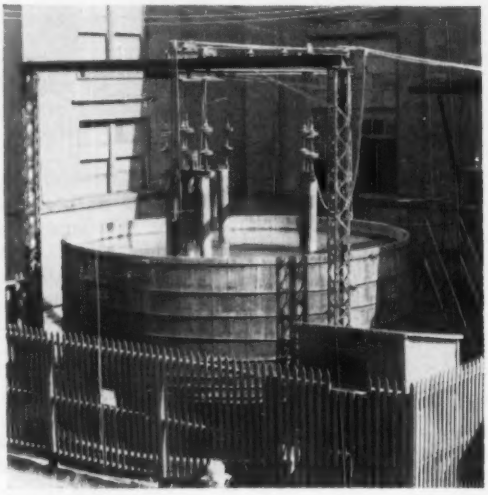
Impurities in the electrolyte play hob with metal parts. So when using sodium carbonate hold impurities in the powder to within .5% . . . that is, impurities in the form of sodium chloride (NaCl) or sodium sulfate (Na_2SO_4). If sodium bicarbonate ($NaHCO_3$) is present it should be held to within 1%. These measures will aid in retarding corrosion. Use either distilled or condensate water when mixing the electrolyte. From a maintenance angle, see that systems are drained and cleaned, and electrolyte replaced with a fresh solution yearly.

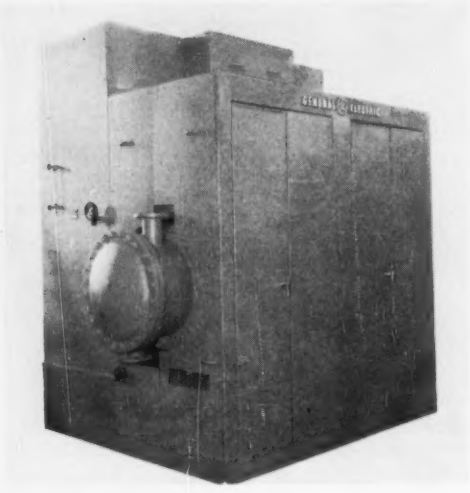
When horizontal electrodes were first used, insulation was necessary between phases. Originally, ordinary sewer pipes were set over the electrodes and small slots cut in the bottoms to allow thermal circulation of electrolyte. Pipes were later superseded by cells made of a material called *electrical stoneware*. To overcome breakage in shipment, rubber-lined steel cells have also been used, but openings at the bottom were eliminated to increase resistance between electrodes. In some installations, individual cells have been fabricated of an insulating compound and then mounted independently, rather than in large tanks. Other rheostats have been made using one tank with three rubber-lined compartments, but a lightweight, practically nonbreakable glass fiber material with an epoxy binder has also been used as an insulating liner.

Insulating a liquid rheostat is, of course, an important problem. With secondary voltages as high as 2000, the isolating effect of the cells still permits grounding of the outer tank.

In some larger installations where voltage exceeds 2000, equipment size has made use of three separate insulated tanks more practical. In these systems, the electrolyte is transferred through pipes made of rubber or some similar insulating material. Nature of the seals that must be used to insure insulation of the higher voltages, however, makes it more difficult to provide a water-tight connection from the fixed electrode to the outside tap. One installation, discussed later, controls the 250,000-hp load of a wind tunnel. Here each rheostat consists of three rubber-lined steel tanks, individually insulated from ground.

An early system for removing heat





Early liquid rheostat designs bow to modern metal enclosures

Compact metal-enclosed design, well entrenched in the switchgear area, has become accepted in the field of liquid rheostats. Unit, above, left, is an old-timer installed at GE's Schenectady Works for testing purposes. Streamlined design, right, is for a 9000-hp 6600-v induction motor. Here, heat exchanger, electrolyte pump and rheostat are mounted and piped in one package.

Older wooden-vat water rheostats were often used for generator testing. In one case of interest to do-it-yourselfers (POWER, July 1950, p 106) an 8-ft diameter 10-ft high vat was being used for field testing 2.4-kv generators. Generator test voltage was first adjusted to 5 kv. Water rheostat electrodes were lowered slowly until water contact was made. Heavy arcing resulted, stopping the test until a trouble-free angle was thought out.

Solution? Best bet and a practical answer to the problem turned out to be ordinary 6-in. tile pipe about 27-in. long. One tile pipe was tried for each electrode. This setup allowed dunking electrodes a depth of 2 ft for full load. But to get good loading regulation, two sections of tile pipe were provided for each electrode.

"The package unit rheostat has come into being"

developed in the rheostat consisted of cold water coils immersed in the upper part of the solution to induce thermal circulation. Other systems cool the electrolyte in separate tanks. Probably the most efficient method is the use of a liquid-to-liquid heat exchanger where the hot electrolyte flows around a bundle of tubes through which cold water is circulated. These exchangers can be made to fit any load and can be mounted either externally or with the rheostat as a packaged limit.

In steel mills, the packaged unit liquid rheostat is now in general use. A typical installation at the Sparrows Point plant of the Bethlehem Steel Company is operated by a torque motor and is used in conjunction with a flywheel motor-generator set to reduce its speed when the load rises above a preset value. As the load becomes excessive the regulating system, which supplies power to the torque motor, causes the electrodes to separate and increase the resistance of the wound motors' rotor circuit. As the motor slows down, the flywheel temporarily carries the excess load. When the load returns to normal, the electrodes are moved together causing speed to increase, thereby restoring energy to the flywheel. This system is particularly effective where sudden load fluctuations are encountered.

Another application of the liquid rheostat is in the control of motors used in wind tunnels. Lead photo, p 124, shows part of an installation composed of seven liquid rheostats used to control a total of 250,000 hp. These rheostats are at the Lewis Unitary Plan Activity Tunnel near Cleveland, Ohio. Each consists of three large rubber-lined steel tanks, individually insulated from the ground. Electrodes are raised and lowered by a pilot motor. Each pilot motor, with necessary gearing, limit switches and sprockets, is suspended from overhead I-beams.

Liquid rheostats are being used in the U.S. as speed controllers for draft fan and pump motors and the large motors driving wind-tunnel compressors. They are also being applied in the steel industry, on dredges for control of speed and load and on mine hoists.

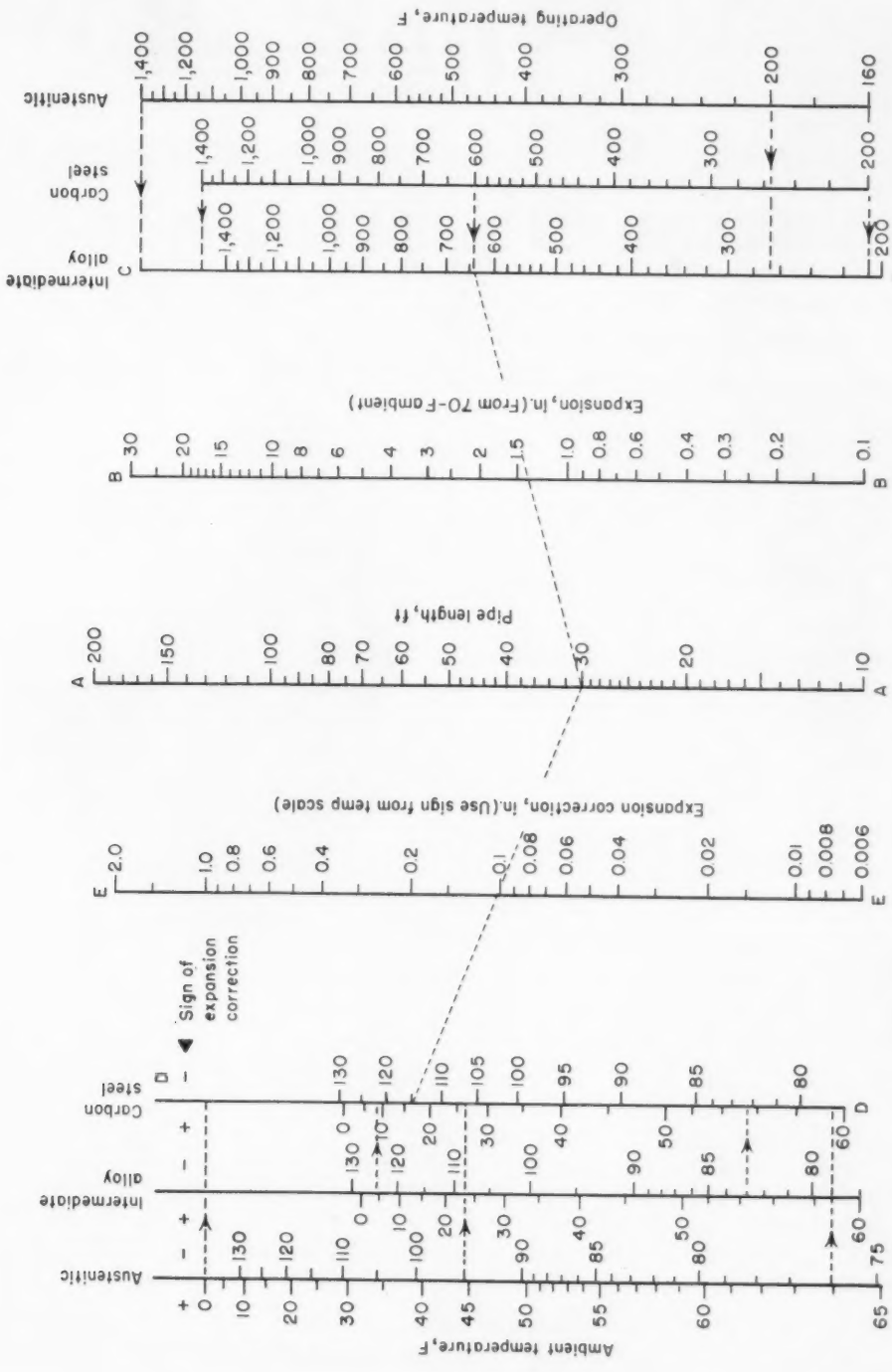
In England they are applied in starting large induction motors and as neutral-grounding resistors. They have also been used in Canada in mining and dredge service.

Other new applications are continuously being found, and the liquid rheostat is gaining in acceptance throughout the electrical world.

Power's DATA SHEET

No. 304

Thermal expansion of piping steels from 0 to 1400 F



▶ THESE PIPING EXPANSIONS for various steels are based on ASA B-31.1—1955 *Code for pressure piping*. Carbon steels include carbon moly and low-chrome steels through 3%; intermediate alloys include chrome moly from 5 to 9%.

To figure expansions from 70-F ambient use scale *AA* and those to right. To correct for different ambient use the center scale *AA* and those to the left.

Example: Find total expansion for 30 ft of carbon-steel piping at 600 F above 115-F ambient.

Find 600 F on carbon-steel scale at right; project line perpendicularly to *CC*. From intersection lay straight edge to 30 ft on *AA*. Read 14-in. expansion above 70-F ambient on scale *BB*.

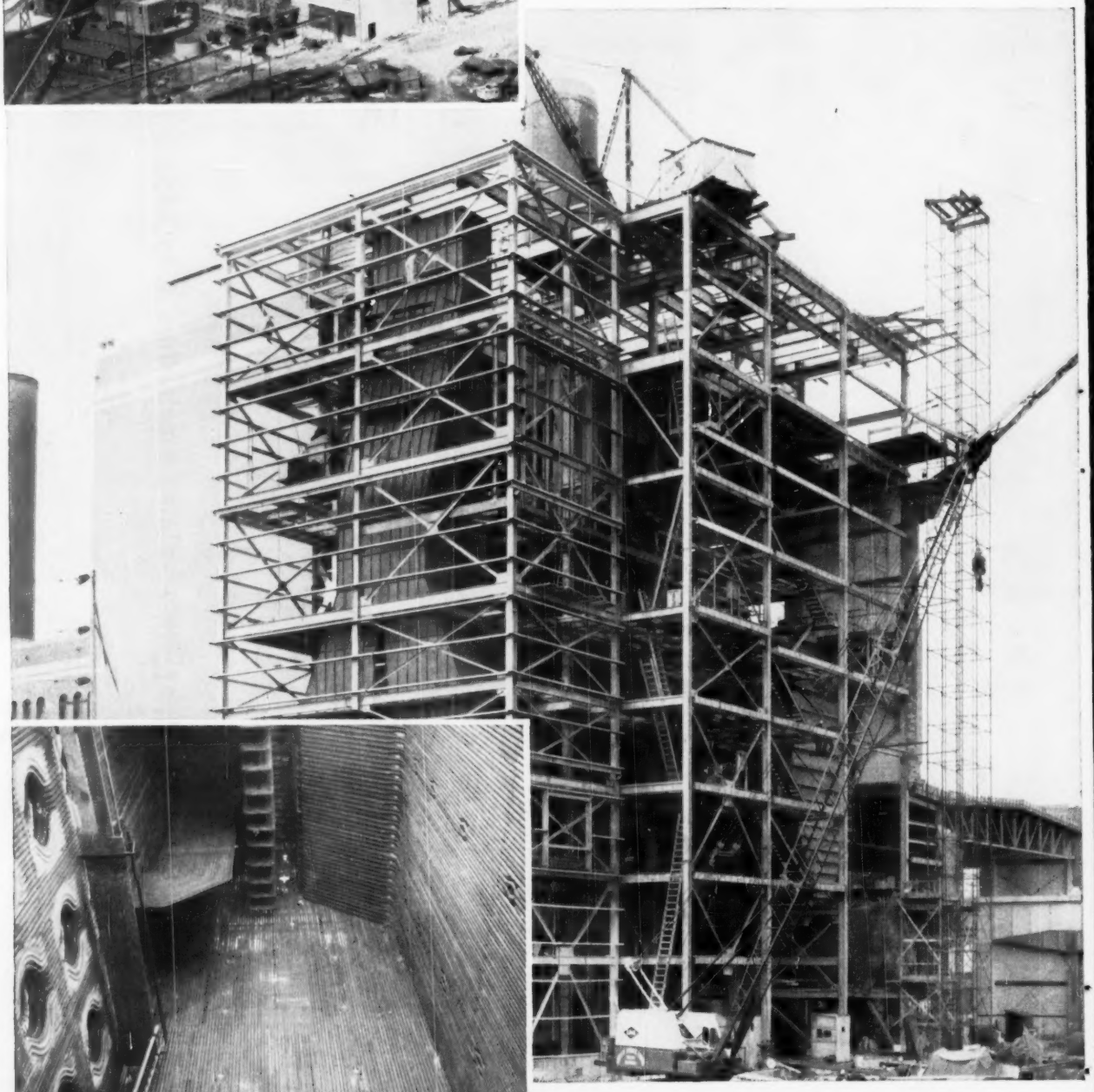
Next find 115 F on *DD*. Lay straight edge to 30 ft on *AA*, read 0.1 in. expansion correction on *EE*. Note negative sign above scale on *DD*. Then expansion above 115 F = 1.4 − 0.1 = 1.3 in.

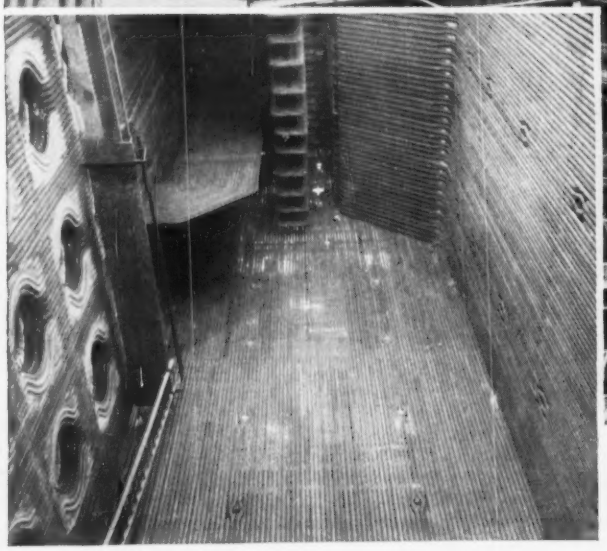
Note: Project all temperatures to either scale *CC* or *DD* as indicated by dotted lines.

J F WATERS, *Westerham, Kent, England*

© POWER

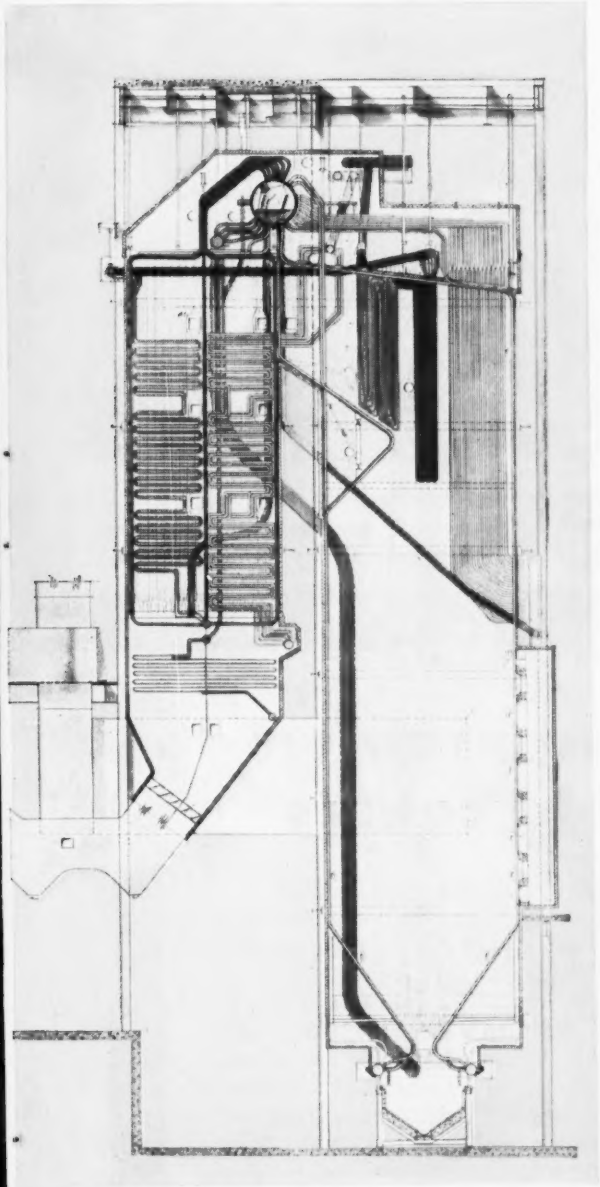
This is R. S. Wallace Station showing modern enclosure for Unit No. 6, a 600,000 lbs./hr. Riley Boiler. Below, Unit No. 7 under construction.





Inside furnace of Unit #7 at E. Peoria. At left — 5 of 16 Riley Flare Type Burners; burner openings are water-cooled. Top left — one of two bare tube platens that are employed to evenly distribute furnace heat across superheater and reheater.

Sixth RILEY Boiler at R. S. Wallace Station



Capacity — 690,000 lbs/hr.
Drum pressure — 1650 psig
Superheat, Reheat — 1000 F
Fuel: Central Illinois Coal
Average Overall Efficiency — 87.7%
COMMONWEALTH ASSOCIATES, INC.
CONSULTING ENGINEERS

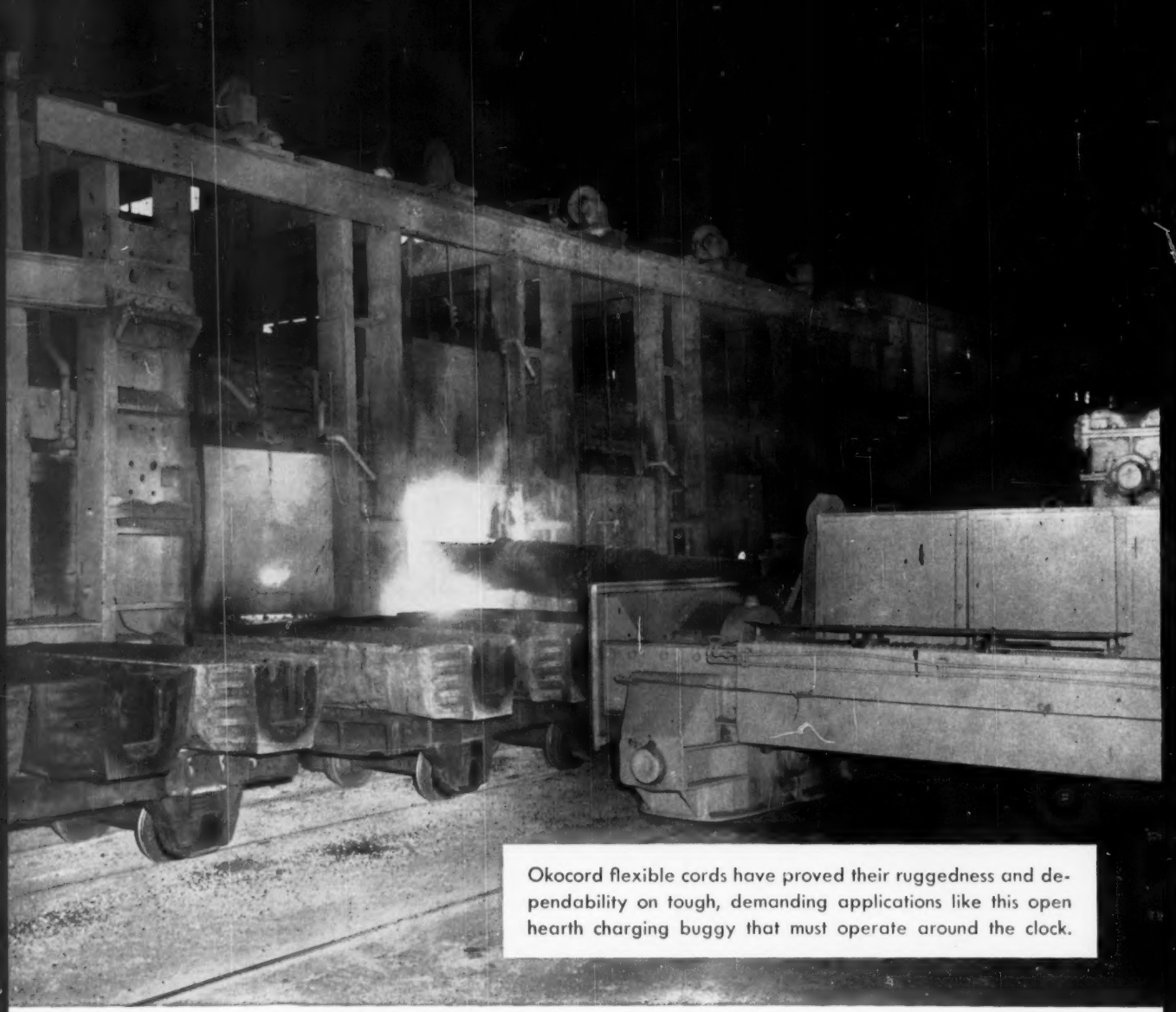
CENTRAL ILLINOIS LIGHT COMPANY has also ordered its EIGHTH Riley Boiler for its Lamarsh Station

Since 1939, Central Illinois Light Company has installed six Riley Boilers in its East Peoria R. S. Wallace Station. The latest, a 690,000 lb/hr Reheat Unit is illustrated here and will shortly go on the line. The recent order of an 850,000 lb/hr Reheat Unit for Lamarsh Station will bring the total of steam generated by Riley boilers to 3,415,000 lbs/hr. Dependable operation, and high availability are the operating characteristics of these Riley boilers.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs. .

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.



Okocord flexible cords have proved their ruggedness and dependability on tough, demanding applications like this open hearth charging buggy that must operate around the clock.

Heat and abuse . . . no problem for Okocord* portable cables

The charging machine above is controlled by Okocord flexible cables. They have to withstand constant heat and abrasion. And they're wound and unwound about a small reel every time the charging arm enters the furnace—literally hundreds of times every day.

Okocords are used for tough applications like this because they've been proved in service in steel mills . . . and in every other kind of plant. The rugged Okoprene sheath has superior flame resistance . . . plus the tire-tread toughness and extra flexibility that come from being cured in a continuous metal mold. The Okocord conductors have maximum flexibility because they are made of fine copper wires twisted together with a short lay.

Add to this Okocord's carefully-selected, tough, heat-resisting insulation and Okonite's reputation for superior engineering and manufacture . . . and you'll see why you should specify Okocord for every tough portable cord and cable application. Get complete details from your Okonite salesman or write for Bulletin PW-451. The Okonite Company, Passaic, N. J.

*This product formerly carried the trade name Hazacord

where there's electrical power . . . there's **OKONITE CABLE**

4903

STEVE ELONKA
Associate Editor in Charge

Drilling square holes through glass is duck soup for . . .

Silent sound: smart approach to tomorrow's maintenance

By **RALPH REYNOLDS**
General Sales Manager
Acoustica Associates, Inc

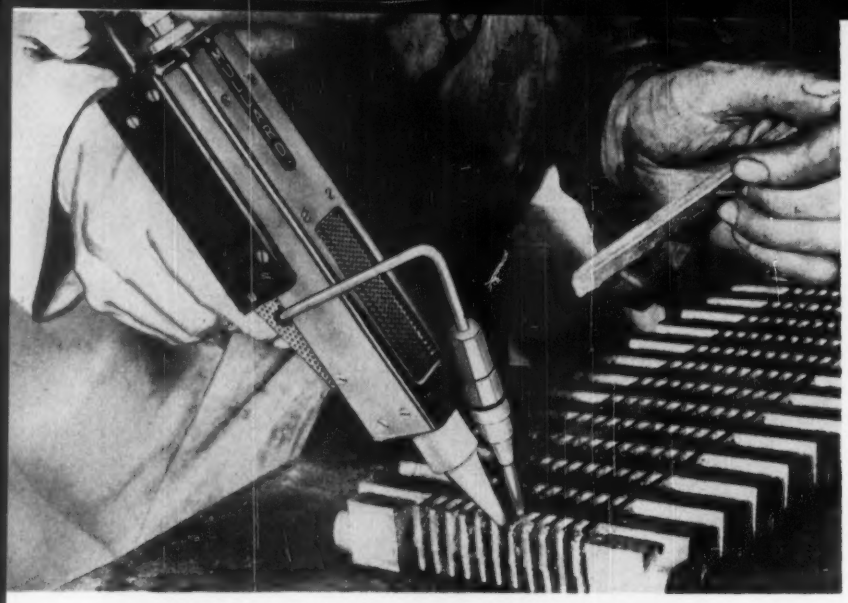
► ENRICO CARUSO strode to the middle of the packed ballroom. A man held a delicate wine glass lightly between his thumb and forefinger. Caruso's great voice sounded a single note that rose to seemingly impossible heights. The pitch became almost unbearable, interminable—then a gasp from the crowd, a tinkle as the shattered wine glass fell to the floor. Only the fine stem remained in the demonstrator's hand. The audience was awed.

This story shows there's nothing new about the idea of sound having powerful properties beyond its communicative functions. In the past few years, electronically produced sound waves have found many plant uses. These waves are ultrasonic, pitched above the 18,000 to 20,000 cps that's the upper limit of human hearing.

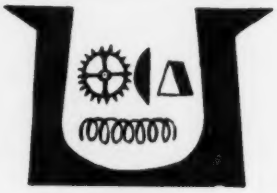
Ultrasonics can be demonstrated with the silent dog whistle, which is inaudible to us imperfect humans, but whose "silent" sound waves register on Fido's wider range of hearing. These waves can travel through air or through liquids and solids, just as ordinary sound waves do. Ultrasonics differ from audible sound only in number of vibrations per second. Ultrasonic frequency is higher; wavelengths are shorter than audible sound waves.

Electric energy is converted to mechanical energy by one of two types of transducers, piezoelectric or magnetostrictive. The first relies on fact that high-frequency alternating electric energy when applied to quartz, barium titanate or similar crystalline material causes it to expand and contract. In the magnetostrictive type, sound energy is developed by passing an alternating current through a coil surrounding material like nickel or nickel alloy—whose actual physical dimensions change under influence of a magnetic field.

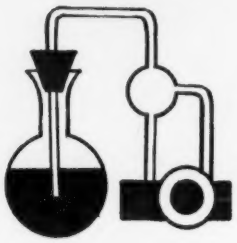
How it works. Power of these ultrasonic vibrations is considerable. When



Soldering with silent sound needs no flux, job is cleaner



Cleaning materials



Viscosity measurement

Here are nine different ways you can use silent sound to

passed through a liquid at a high energy level, ultrasound produces cavitation. This phenomenon is the actual rupturing of the fluid, with consequent forming of vacuum pockets and reforming of fluid at rate equal to frequency of energy input. During fluid rupture, microscopic vapor globules form as tension phase of transmitted wave passes through fluid. During compression phase of wave, these globules collapse with tremendous force. Because of their great implosive force, collapsing globules impinging on surfaces can physically remove the adhering deposits.

In the process of cavitation, bits of soil clinging to the surface of an object are torn away by agitated liquid. In some cases, depending on material and time of exposure, surface literally erodes.

Different frequencies are used for various applications. For example, 18,000 to 40,000 cycles frequency is usually used for machining, metal cleaning, degassing, dispersing, heat transfer and plating. For nondestructive metal testing, such as thickness gaging or flaw detection, frequencies ranging from 0.2 to 25 megacycles are used.

Cavitation properties of ultrasonics make possible a major use—cleaning and degreasing everything from tiny mechanisms to rough foundry castings.

When a hard object of glass, metal or ceramic is immersed in a cleaning fluid being vibrated by ultrasonics, cavitation on its surface removes any contaminant. There's no surface damage to the piece being cleaned. Parts can be cleaned in relatively dirty solvents and still emerge spot free. Why? Because drag-out of contaminant from cleaning solution is 10% of normal.

What does it clean? Cavitation gets into the tiniest of spaces, into inaccessible crevices. Therefore, motor and generator armatures, turbine blades, electric or gas meters, fuel nozzles, relays, oil-purifier bowls, timers, gages and other devices can be perfectly cleaned without disassembly.

From other objects (pistons, gear assemblies, carburetors, injection pumps, spark plugs, electrodes), we can see flux, dirt, grease, rust particles, preservative compounds, silicone greases, exhausted lubricants and other contaminants flying away. Ultrasonic cavitation also scrubs away corrosive flux of soldering operations.

Reasonably priced equipment is now available for powering mass-production, batch or automated cleaning systems. This cleaning lends itself to complete automation. It can be added to soak degreasers, vapor degreasers and metal washers. Conveyorized systems are used in metal working and other industries. High-power ultrasonic generators and transducers adaptable to most tank configurations and dimensions—simple electronic or motor-driven alternators from 5 to 150 kw—are on the market.

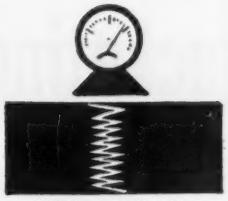
Atomic power plants also use ultrasonics. Silent sound removes scale from reactor rods, cleans bundles without disassembly, decontaminates uranium-enriched fuel rods withdrawn "hot" from a pile or instruments used in "hot" labs. It also cleans isotope-source material prior to irradiation. Units are adaptable to remote-control operation, thus eliminate manual scrubbing or sandblasting. Ordinarily, these are major personnel hazards. Warm water, detergent and a chelating agent serve as decontamination washes.

Machining. Magnetostriction transducers are used also to energize ultrasonic drills, solder pots, soldering irons, crucibles and grinding devices. Hole is made by vibrating an abrasive slurry with a shaped bit on the surface to be drilled. Glass, metals, ceramics and such hard materials as tungsten, titanium carbides or even diamond can be machined. Brittle materials thus machined won't fracture or chip.

Because these new tools reciprocate instead of rotate, they aren't limited to cutting circular holes. You can make intricately shaped holes.

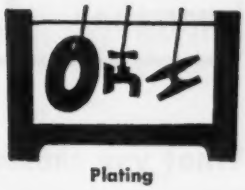
Tool tip acts as a Lilliputian battering ram whose amplitude of motion is is the order of 0.005 in. Moving tip makes the abrasive particles strike the surface many thousands of times per second, eroding away minute particles each time the tip strikes. This rapid process has an added advantage: it is not limited to electrically conductive materials. It causes no deformation, discoloration or burning of workpieces. Since motion of drill is longitudinal, tolerances can be kept to 0.0005 in.

Surface finishes of eight to ten microin. are easily obtainable with ordinary

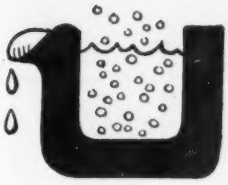


Thickness testing

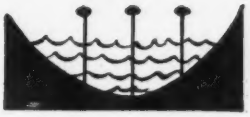
Drilling and grinding



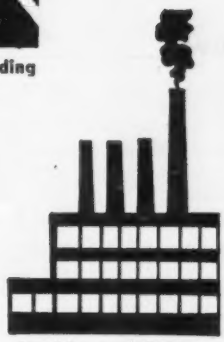
Plating



Metallurgy



Stream measurement



Particle precipitation

Fluxless soldering

lick some of your tough power-service problems

abrasives. With 120-mesh abrasives, dimensional accuracy is between 0.002 and 0.003 in.; with 1000-mesh abrasive, finishing may be to order of 0.0005 in.

High-frequency vibrations applied to usual grinding operations to control work feed improve surface finishes, reduce temperatures and incidence of thermal cracks. Vibrations of 0.001-in. amplitude at 10 to 18 kcps can result in a 50% reduction of roughness (from 40 to 16 micro-in.) This technique is valuable for grinding dead soft aluminum, low carbon steel or carbide tools.

Soldering. Another use is in fluxless soldering of refractory metals, like aluminum and magnesium. It's again the cavitation force in liquid—this time in molten solder or a tinning bath—that breaks down the rapidly forming metal oxides on surfaces of nonferrous parts to be joined. Clean oxide-free surface using ultrasonically activated solder makes possible a bond stronger than the base metal itself. You don't have to use soft-solder scratch brush, corrosive acid or resin fluxes. Ultrasonics in soldering is useful in splicing aluminum cables and wires, joining aluminum bus bars and repairing cracked aluminum housings.

Copper and brass electrical apparatus parts thus soldered make more reliable joints. Also, acid-free solder is more suited to passage of electric current. In soldering connectors, printed circuits, tube bases, transistor cases and similar parts, corrosion by fluxes is eliminated. These soldering techniques are used in metal fabrication, cable splicing and salvage of porous or cracked castings.

Level indicators. Transducers fixed at a specific level in tank to be filled with water, petroleum products or any liquid will cause automatic shutoff, transfer or other required function when liquid level reaches transducer. Upper and lower liquid levels in a buried fuel tank, a boiler feedwater tank or the boiler itself may be ultrasonically detected and controlled.

One class of ultrasonic liquid-level sensors can function in a temperature environment of −300 F to +200 F. Another class is available in range of 200 F to 500 F. These sensors are extremely accurate (± 1/32 in.), immediately responsive and not affected by pH, viscosity or electrolytic character of solution. They contain no moving parts, are corrosion free and need no maintenance. Also, ultrasonic sensors are inexpensive. Newest sensors continuously indicate exact level at any instant.

Liquids-viscosity measurement is another use. Just insert a thin blade in liquid to be gaged. Periodic blade vibration and measurement of damping rate of the blade after ultrasonic power is removed give remote, low-cost viscosity readings.

Nondestructive testing of many objects, from metal castings to rubber tires, is common. Ultrasonic waves sent through metal produce an echo at level of crack, flaw or blowhole. Big advantage of ultrasonic testing is that flaws within intricate assemblies may be detected and located.

Thickness gage. Silent sound measures inaccessible surfaces, sets mill rollers automatically, and tests effects of erosion and corrosion in pipes, hull plates, boiler plates and storage-tank walls.

Harmful gas in liquids is the bugaboo of boiler plants; chemical-processing plants engaged in vacuum packing, canning and manufacture. Any liquid degasses rapidly when agitated by high-frequency sound vibrations.

Degassing is highly important to metallurgical industry. Gases entrapped in melts interfere with most metals, especially aluminum, magnesium and titanium. Ultrasonic degassing of boiler feedwater will eliminate carbon dioxide and oxygen entrapments, causing rust and scale.

Air pollution. Reducing air pollution, de-smogging and particle precipitation are other uses. Smoke exposed to intense sonic or ultrasonic energy tends to display particle agglomeration over a range of particle sizes not affected by electrostatic precipitators.

The new static-type sonic "whistles" are very efficient. These devices, using compressed air as the power source, should find widespread use in industrial flues for control of zinc- and aluminus-oxide fumes, carbon black, tobacco smokes and obnoxious smogs. Valuable byproducts may also be recovered. Every plant engineer can find a number of uses for silent sound.

OPERATORS' NOTEBOOK 114

Today, aluminum jacketing

What you should know

► ALUMINUM is now used by power engineers for jacketing insulated surfaces. Thicker and tougher sheets sustain good appearance, cost less to apply and cut maintenance. You can install jackets with superior properties at no increase in price over established finishes.

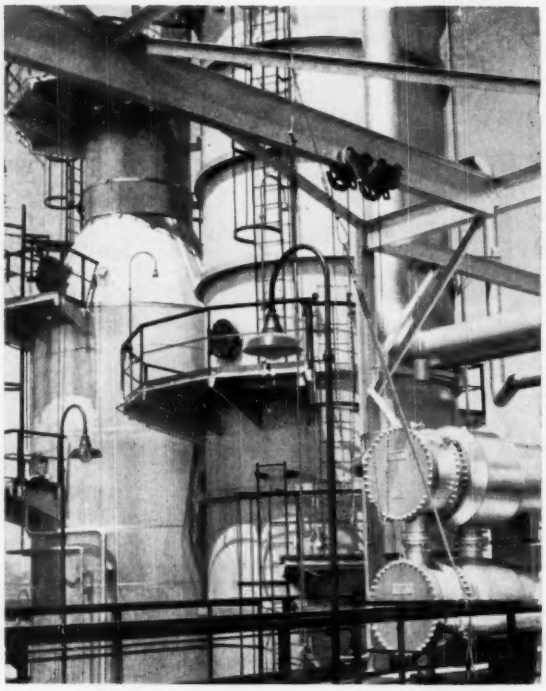
Thickness and alloy strength determine resistance to denting, abuse from foot traffic, ladders, scaffolding, planks, etc. Jackets of right thickness and strength also save application costs, need fewer fasteners. Aluminum's excellent weather resistance assures long life; it won't rust, rot, warp, shrink or need painting. Tough protective film of aluminum oxide, formed by exposure to weather, re-forms after scratches and many corrosive actions occur.

Pipe jacket. Application is simple; cut sheets from coils, roll into tubes, snap over insulation and fasten. Term "snap-jacket" has been used to describe these rugged tubes. Using them saves money three ways: they (1) snap on quickly (2) need fewer fasteners (3) need no painting. You or your contractor can make snap-jackets easily by cutting measured lengths from coiled sheet of proper alloy and thickness. Then temper and stiffen outer lap edge of each sheet. Roll form it into a tube, snap-fasten until you're through. Tube thickness should be 0.020 in. for OD's to 14 in., and 0.025 in. above that.

For vertical vessels corrugated sheets of 0.024 in. are best. For fastening use welded studs (or angles), bands and S-clips. Cut jackets for vessel heads, fittings and flashings, then shape with hand or power tools.

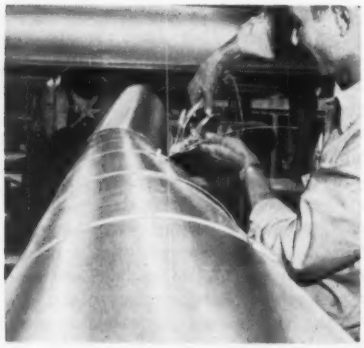
Fittings. Elbows can be preformed or made from gores. Long radius bends can be wrapped spirally using narrow coils and lapping 1 in. per turn. Work pre-applied mastic weather-proofing into each lap.

Simple precaution to avoid corrosion: Don't attach aluminum to copper, copper alloys, tin, lead, nickel or monel. If a steel-aluminum joint gets wet, prime steel with zinc chromate and paint with aluminum paint. (Don't use lead paints.) You can use high chrome stainless steels for high strength fasteners and bands to secure aluminum jacketing.

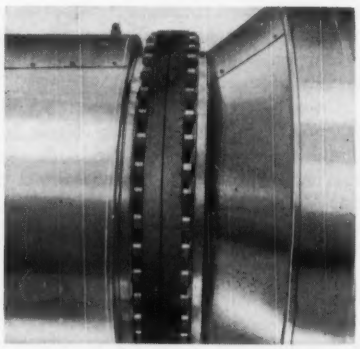


Aluminum applied bare over the common insulating materials (calcium silicate, 85% magnesia, amosite asbestos, glass, etc) has resisted conditions of wet insulation occurring during shutdowns and construction. Excessive wetness is risky and should be avoided. Let rain-soaked insulation dry out a few days before installing aluminum jacket. Overly-wet jacketed insulation is usually caused by poor flashing, not condensation. For more details, send for *Insulation jacketing—materials and methods*, Kaiser Aluminum & Chemical Sales, Inc, Chicago 11, Ill.

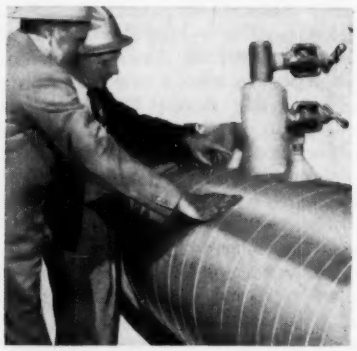
Fastenings and fittings



BANDING takes teamwork. One man snaps the jackets into place, other bands



REDUCING SECTION on a heat exchanger may be jacketed so the nuts are exposed

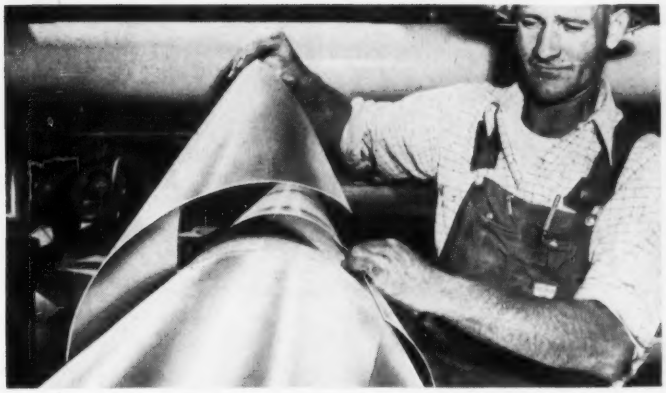


INVERTED FUNNELS or rain hats are snipped from scraps, formed into shape

protects your insulation

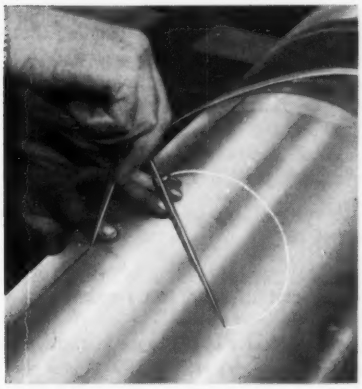
By STEVE ELONKA, *Associate Editor*

Fits around tees like this



1 Snap, band a straight pipe jacket on branch leg of tee close to through leg. Place another full section of jacket loosely around through leg

2 Determine outside diameter of branch leg and measure the same distance on the edge of lap



3 With jacket placed around pipe, compass center near edge of the lap

4 Cut out half circles from each edge of jacket, following the compass lines

5 Snap the jacket into place at tee and band. Seal void where jackets join

Snapping into place is easy

Open

Push

Snap

Application. After tubular jackets are formed, they are ready to be snapped in place over pipe insulation. On vertical runs of pipe, install jacketing from bottom up to assure proper drainage away from end laps. One or two S-clips at each joint will prevent slipping and permit expansion.

On horizontal runs, locate longitudinal lap joints weatherwise on lower part of pipe, at 4 to 8 o'clock position. That insures proper run-off. Place one band at each 3-in. lap, and one band in between. Center band should be tighter than lap bands. Lagging with this snap action aluminum jacketing is fast, saves on installation costs.

Running field tests on your centrifugal pumps is one of the best ways to "look inside them" without actually opening them up. Test data gives you a practical check on original estimates of head and capacity, an accurate picture of operating costs. Here's your complete guide on . . .

How to field test your centrifugal pumps

By F W BELTZ Jr, *De Laval Steam Turbine Co*

► FIELD TESTING centrifugal pumps provides the plant engineer with a valuable tool for determining condition, checking original estimates of head and capacity, getting an accurate picture of operating costs and a host of other useful facts. But . . .

WHY NOT RELY ON MANUFACTURERS' TESTS ALONE?

Regardless of how good pump performance is in the manufacturer's test lab, your permanent installation is the final testing ground. Such tests compare operating conditions to conditions called for in your purchase agreement. They check the accuracy of the hydraulic performance estimate, motor size, piping- and valve-size estimate and system head curve. If field tests show up important errors in any of these items, you can often have them corrected, sometimes even before the unit goes on the line.

Field testing, as we've seen, also yields an accurate picture of operating costs. They tell you the power requirements of single units, or of a group in series or parallel operation. Armed with this data you can pick out the most economical operating pattern. Result is important savings in power and fuel. Fertile areas for such savings are installations of large high-pressure pumps, although returns on even small units can be substantial. And if you're planning to add pumping capacity to your system, the field test can often point the way to the most economical method.

After your pumps have been running for some time, you can also run field tests to compare sustained efficiency and find the actual cost of running the equipment.

Most unique and probably the most useful function of field testing: It allows you to "look inside" the pump without interrupting operation and without major manpower expense. Pump performance is your best guide in determining need for replacing impellers, casing rings, interstage and breakdown bushings. And comparative performance data from periodic tests can tell more about pump condition than internal inspection and clearance measurements. By carefully observing test results many plant engineers have been able to keep units on the line for five to six years without overhaul—a clear-cut improvement over the practice of either annual or semiannual inspections.

Manufacturers often sell large water-works pumps on a penalty-bonus contract basis that calls for running field tests. Results of these tests can mean a bonus award or a penalty charged to the pump builder, depending on whether the unit exceeds, meets or fails to meet the performance guarantees. Contracts like these often carry evaluations as high as $10,000 per point of efficiency. Tests are run under exacting conditions, eliminating all possible errors and correcting for all variables.

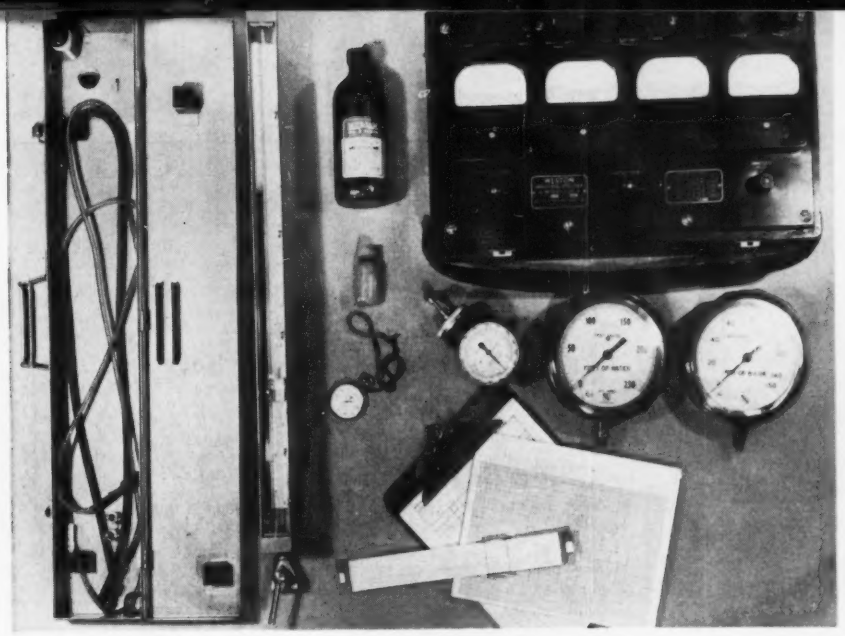
PLANNING, RUNNING THE TEST

Careful planning, plus a full understanding of what you're looking for, is the key to getting valid test results with a minimum of plant interruption.

Before doing any testing, select and calibrate instruments, and make necessary connections, drawing p 139. Then prepare data sheets with spaces for entering all needed data. By thinking ahead you'll avoid omitting notations such as how or where a particular gage was connected. This is also a good time to choose the approximate test-flow increments and to figure the meter readings required to produce these flows. Be sure to take a good distribution of data over the full range of the pump. While you'll usually have little trouble in running the pump over its full range without disrupting plant operations, it'll pay to check and synchronize your testing with other departmental plans.

Don't begin testing until all instruments have been checked and everyone is familiar with the procedure. Set first test point at highest capacity, lowest head. If flow isn't constant because of system head changes, operator at the discharge valve should adjust it to maintain desired flow. If readings are steady, one set is enough; but if there appears to be an appreciable change, take four or five sets of readings and average them. Establish additional test points by adjusting the discharge valve until reaching zero flow. Often, the zero point won't be needed. But when it is, hold the unit at shutoff only momentarily for a spot reading; then open valve up again.

Often, you may have trouble getting the head low enough to reach high-capacity points. If you're pumping into a standpipe, work level down to a minimum before the test,



These simple tools speed pump tests

The relatively simple array of equipment at left is your complete kit for running pump tests. From left to right, we see a portable manometer, manometer fluid, stop watch, tachometer, graph paper, slide rule, pressure gages and an industrial analyzer

References

1 ASME *Power Test Codes, Centrifugal Pumps,* published by the American Society of Mechanical Engineers, 29 W 39th St, New York, N. Y.

2 *Standards of Hydraulic Institute, Centrifugal Pump Section,* published by the Hydraulic Institute, 90 West St, New York, N. Y.

3 *Fluid Meters, Their Theory and Application,* Part I, published by the American Society of Mechanical Engineers, 29 W 39th St, New York, N. Y.

Letter symbols

Symbol	Term	Unit dimension
A	Area	sq ft
bhp	Pump power input	horsepower
C	Flow coefficient	——
D	Diameter	inches
E	Overall efficiency	percent
E_g	Driver efficiency	percent
E_m	Motor efficiency	percent
E_p	Pump efficiency	percent
g	Gravitational acceleration	ft per sec per sec
H	Pump total head	ft of liquid
h	Meter head	ft of liquid
h_d	Discharge head	ft of liquid
h_g	Liquid column or manometer reading	ft of liquid
h_s	Inlet or suction head	ft of liquid
h_v	Velocity head	ft of liquid
h_{HG}	Mercury column reading	inches of Hg
K	Velocity head constant	——
N	Number of turns	——
n	Speed of rotation	rpm
p	Pressure intensity	psi
p_g	Pressure gage reading	psig
p_{HG}	Vacuum gage reading	inches of Hg gage
Q	Capacity of pump	gallons per minute
S	Specific gravity of liquid	dimensionless
T	Time	seconds
V	Liquid velocity	ft per second
W_w	Water flow	lb per hr
W_s	Steam flow	lb per hr
W	Weight	pounds
w	Specific weight of liquid pumped	lb per cu ft
w_g	Specific weight of manometer indicating liquid	lb per cu ft
whp	Useful pump output	horsepower
Z	Elevation of measuring point above datum (minus if below datum)	ft
Z_s	Elevation of suction measuring point above datum (minus if below datum)	ft
Z_d	Elevation of discharge measuring point above datum (minus if below datum)	ft

or isolate the unit from the system and discharge the water to a low-pressure point.

Low-head pumps can be tested in a closed loop with good results if the loop has sufficient volume to control turbulence.

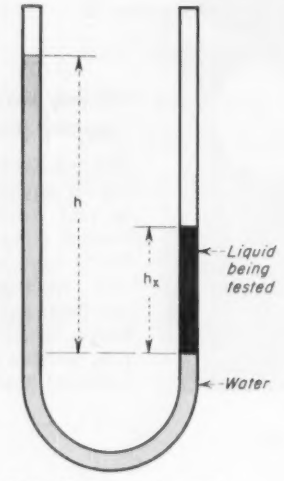
Smart approach: Make a rough calculation of the data while the test is in progress. It's a good way to spot bad data or faulty instruments before the test is complete and instrumentation removed. You can do your figuring with sufficient speed and accuracy on a 10-in. slide rule.

HOW TO MEASURE TEST DATA

Centrifugal pump performance depends on four or five variables, (see "Centrifugal pump theory," p 144). Basically, these variables are the flow or quantity of liquid pumped, head or pressure rise across the pump and power input. If liquid temperature varies substantially then specific gravity is a variable. Also, speed may be a variable. Simplest condition is to pump cold water with a constant-speed pump. Hot-water pump, operating over a range of temperatures and speeds, is a more complex problem.

Flow. Easiest variable to measure if you've the right instrumentation is flow. Several measuring methods are

How to check specific weight of manometer fluid



Note: Measurements must be exactly vertical

Referring to drawing at left:

$$\frac{h}{h_x} = \frac{w_x}{w} = S_x;\ w_x = \frac{w \times h}{h_x}$$

$$\text{Specific gravity} = S_x = \frac{h}{h_x}$$

Example: water is at 68F, $h = 17.05$, $h_x = 7.75$

$$w_x = \frac{62.32 \times 17.05}{7.75} = 137.1$$

$$S_x = \frac{17.05}{7.75} = 2.20$$

Specific weights and specific gravities of common manometer fluids:

	w_g	S
Mercury, Hg	845.90	13.546
Water at 68 F	62.32	1.000
Carbon tetrachloride, CCl_4	99.40	1.594
Acetylene tetrabromide, $CHBr_4$ $CHBr_2$	184.70	2.964

Carbon tetrachloride and carbon tetrabromide should be tinted with either a pinch of iodine crystal or with one of the dyes available from instrument suppliers. The specific weight should be checked occasionally rather than relying on the above figures alone.

Careful measurement of test data is your key to accurate results

accurate enough for field testing if you take readings carefully, make the necessary corrections and calculations.

Permanent instrumentation of flowmeters or recorders is no guarantee of accuracy. If meter is venturi or nozzle type, it must be free of dirt, tubercles and erosion. Be sure to purge the instrument line of air bubbles. Also important: Zero and calibrate the register or recorder by disconnecting lines to the meter and checking the register against a water or mercury manometer. Instruction books for most commercial meters carry full information on how to calibrate them in the field.

If permanent instrumentation isn't available, a survey of the system usually reveals several ways in which flow can be measured. Here are some methods to consider:

Often, there's a tank on either the high- or low-pressure side of the system. It may be in the form of a reservoir, standpipe, settling basin, filter bed, or even a temporary tank installed for test purposes. To measure flow, there must be a provision for isolating tank from the rest of the system so only test water can flow in or out. With this setup you need only to figure tank's surface area and install a vertical scale to measure liquid rise or fall. If vertical measurements are small, use a hook-type gage as an index. This brings the point up from under the surface to minimize the effect of the meniscus. You then use formula (1) p 142 to figure flow rate.

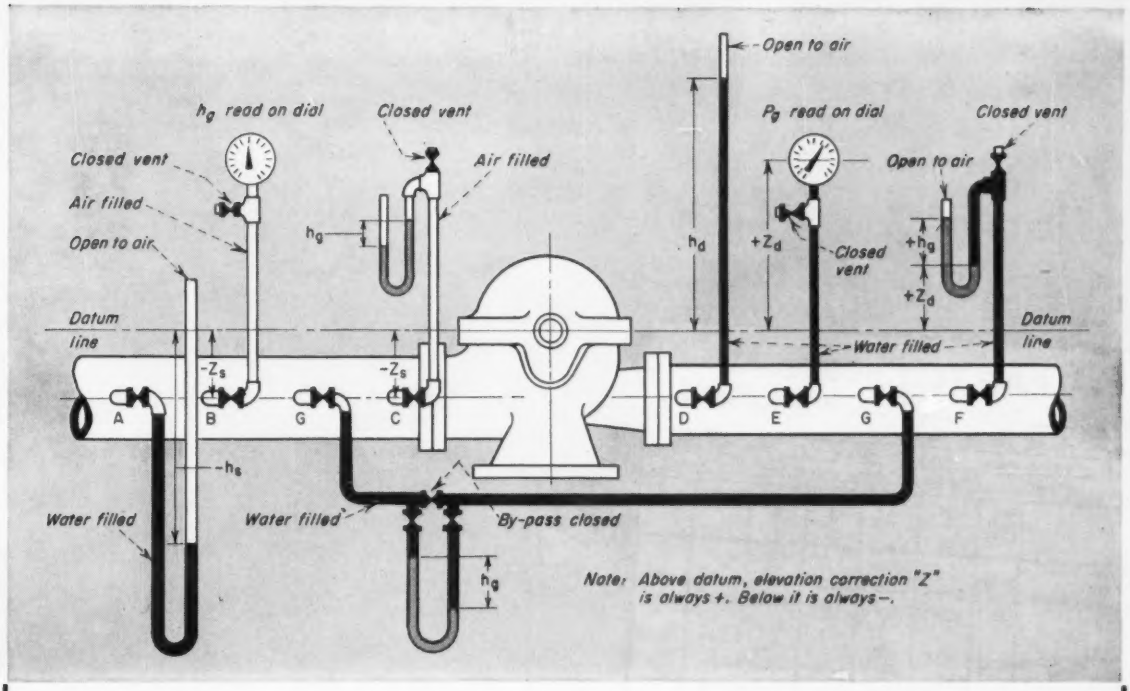
Flow can also be accurately measured with a tank on a platform scale. This is often the easiest way to measure flow of small capacity pumps. Discharge can usually be piped temporarily to an open tank on a large platform scale. You will, of course, need a method of dumping the water to either a sewer or a sump. Be sure there are no mechanical connections between the piping or hose and the tank.

Suggested timing procedure: Adjust the flow before starting water into tank or before closing the dump valve on the tank. Set beam scale so beam is in the down position. Then start flow. As the beam rises to the midpoint, start the stopwatch. Add a suitable weight to the beam to drop it down. When beam again rises to the midpoint, stop the stopwatch. Flow is then figured from formula (2), p 142. This equation is correct for water under 100 F. So, if water is over 100 F, use formula (2a), which corrects for specific gravity.

You can, of course, measure flow with a flowmeter. If your plant can't justify a permanent flowmeter on each pump, and if you have several similar-capacity pumps, you can provide a temporary meter installation for periodic testing. When planning such a setup don't forget to provide a sufficient straight run of pipe preceding the meter. Follow either the manufacturer's recommendation or the test codes. Again, calibrate meters and purge connections of air.

Orifices, nozzles and venturis are usually permanent meters but, as we've seen, they may be installed temporarily for test purposes. They're all based on the same principle: Restriction of flow area resulting in increased velocity and a difference in static pressure across the meter. You can measure the difference with a U-tube manometer, top of page, filled with mercury or one of the middle-range fluids such as carbon tetrachloride or acetylene tetrabromide. Differential pressure gage can also do the measuring job.

Formula (3) p 142, will tell you the flow through any of these meters. Formula (3a) is for a mercury manometer measuring cold water flow. Formula (3b) covers liquid of any specific gravity. Notice that each of these formulas



How to measure and correct suction, discharge pressures to datum line

Suction pressures shown are negative, less than atmospheric. If they were positive they would be measured in the same way as the discharge pressures, with the same elevation corrections. In each case elevations are measured in feet.

Location A: Suction pressure is less than atmospheric, measured with a water-filled manometer. Distance, $-h_s$, measured in feet, is the suction head, in feet of water, corrected to datum line.

Location B: Using bourdon-tube vacuum gage with air-filled line; if gage reads in inches of mercury, then:

$$h_s = (-1.131 \times h_g) - Z_s$$

Location C: Using mercury manometer with air-filled line to measure suction pressure; the deflection of the mercury, in inches, is:

$$h_s = (-1.131 \times h_g) - Z_s$$

Location D: Using water column to measure discharge pressure; distance h_d measured in feet, is discharge head in feet of water corrected to datum line.

Location E: Using pressure-gage reading, pounds per square inch, with water-filled gage line shows:

$$h_d = (2.311 \times p_g) + Z_d$$

Location F: Using a mercury manometer with water-filled line to measure discharge pressure; the deflection of mercury in inches is:

$$h_d = (1.09 \times h_g) + Z_d$$

Location G: Using a mercury manometer to measure the net pressure increase across a pump with all lines filled with water; deflection, read in inches of mercury, is:

$$h_d - h_s = 1.048 \times h_g$$

has a C in it. This is the flow coefficient of the meter. Manufacturer gives you this data. Alternate sources are calibration tests or from *Field Meters*, published by ASME (reference No. 3, p 137).

C is usually constant over the normal meter range. Thus, since physical dimensions of the meter remain constant, we can simplify any of these formulas to the form:

$$Q = K_M \sqrt{h_{HG}}$$

where K_M is the constant for the particular meter and measuring instrument.

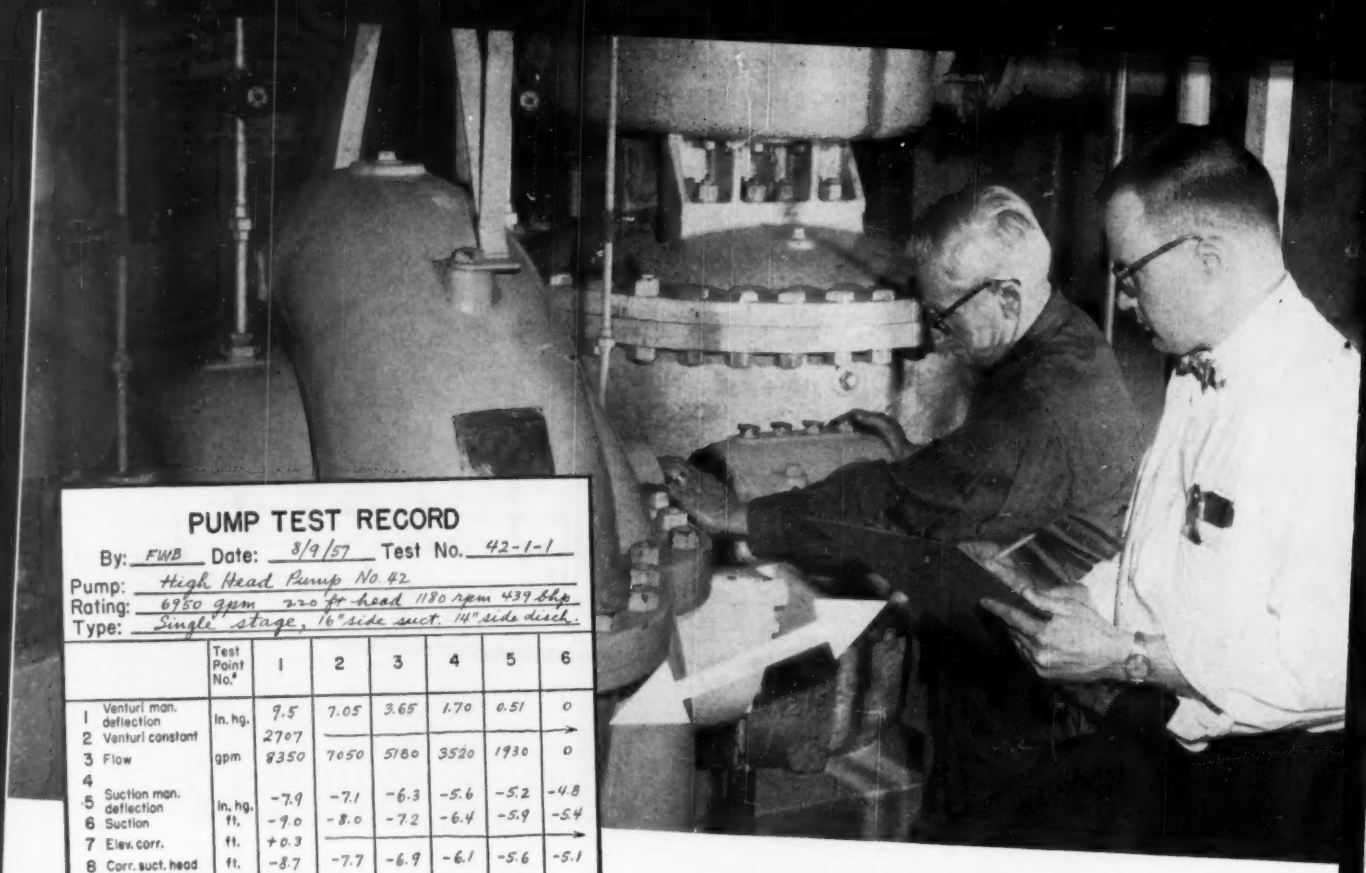
In the typical test we discuss here, we use a venturi of 16.16-diameter inlet by 11.00-in. throat diameter. Water temperature was 67 F. Venturi differential is in inches of mercury. C for this meter is 0.985. So the constant from formula (3a) is:

$$Q = \frac{20.11\ CD_2^2}{\sqrt{1 - (D_2/D_1)^4}} (\sqrt{h_{HG}}) = \frac{20.11 \times 0.985 \times 11.00^2}{\sqrt{1 - (11.00/16.16)^4}} (\sqrt{h_{HG}})$$

$$Q = 2707 \sqrt{h_{HG}}$$

Thus, figuring actual test points boils down to measuring the mercury column deflection, entering it on the slide rule and reading the flow, in gallons per minute.

Typical flow-measuring device is the fire nozzle. It should be of the "smooth-cone" or "smooth-convex-cone" variety.



PUMP TEST RECORD

By: FWB Date: 8/9/57 Test No. 42-1-1

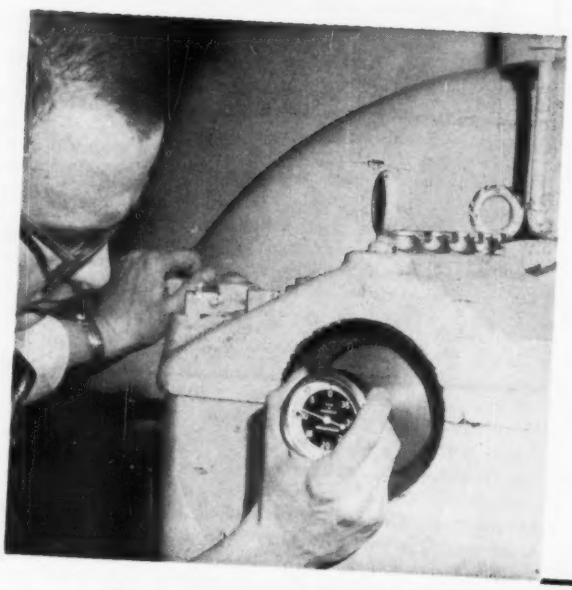
Pump: High Head Pump No. 42

Rating: 6950 gpm 220 ft head 1180 rpm 439 bhp

Type: Single stage, 16" side suct. 14" side disch.

		Test Point No.*	1	2	3	4	5	6
1	Venturi man. deflection	In. hg.	9.5	7.05	3.65	1.70	0.51	0
2	Venturi constant		2707	→	→	→	→	→
3	Flow	gpm	8350	7050	5180	3520	1930	0
4								
5	Suction man. deflection	In. hg.	-7.9	-7.1	-6.3	-5.6	-5.2	-4.8
6	Suction	ft.	-9.0	-8.0	-7.2	-6.4	-5.9	-5.4
7	Elev. corr.	ft.	+0.3	→	→	→	→	→
8	Corr. suct. head	ft.	-8.7	-7.7	-6.9	-6.1	-5.6	-5.1
9								
10	Disch. gage reading	psig	72.6	91.9	102.9	108.6	112.3	116.1
11	Disch. gage corr.	psig	-2.2	-2.4	-0.8	0	0	+.2
12	Corr. press	psig	70.4	89.5	102.1	108.6	112.3	116.3
13	Disch. head	ft.	162.7	206.9	236	251	259.5	268.3
14	Gage elev. corr.	ft.	+1.6	→	→	→	→	→
15	Corr. disch. head	ft.	164.3	208.5	237.6	252.6	261.1	269.9
16								
17	Velocity head constant	k	36,250,000	→	→	→	→	→
18	Velocity head	ft.	1.9	1.4	.7	.3	.1	0
19								
20	Total dynamic head	ft.	174.9	217.6	245.2	259	266.8	275
21								
22	Speed	rpm	1180	1180	1183	1186	1192	1192
23	Water power	hp	369	387	321	230	130	0
24	Wire to water effy	%	72	81.3	78.8	67.3	45.7	0
25	Pump effy	%	78.3	88.3	85.7	73.1	49.7	0
26	Volts avg. 3ϕ	v	442	441	442	440	440	442
27	Amp. avg. 3ϕ	A	575	536	463	394	333	289
28	Power factor		.87	.87	.86	.85	.84	.83
29	Kw input	kw	383	356	305	255	213	183.5
30	Motor hp input	hp	513	477	408	342	285	246
31	Motor effy	%	92	→	→	→	→	→
32	Motor hp output	hp	472	438	375	315	262	226
33	— Test corrected to 1200 rpm —							
34	Flow	gpm	8490	7170	5260	3560	1943	0
35	Total dynamic head	ft.	180.8	225	252	265	271	279
36	Input power	hp	496	460	391	327	267	230
37	Pump effy	%	78.3	88.3	85.7	73.1	49.7	0
38								
39	Notes: Mechanical operation normal. 20"							
40	mercury column on suction side at side tap							
41	gage line dry. 0-200 psi gage on disch.							
42	at side tap calibrated 8/8/57. Plant venturi							
43	16.16" x 11.00" used C = .985, Water 67°F							
	Operation to date 1200 hours							

Here's your step-by-step guide . . .



. . . for measuring and recording

Mount the nozzle on a run of pipe with a pressure tap preceding the nozzle. Formula for any smooth fire nozzle is:

$$Q = 29.0\, D_N^2 \sqrt{p_g}$$

Where Q is flow, gpm; D_N is the nozzle diameter, in.; p_g

How to prepare typical test calculations

Line numbers refer to horizontal line on test record. Numerical examples are for Test Point No. 1.

Line 1: Read in inches of mercury and recorded.
9.5

Line 2: Calculated prior to test and constant for all test points.
2707

Line 3: Calculated.
line 3 = line 2 ($\sqrt{\text{line 1}}$)
8350 = 2707 ($\sqrt{9.5}$)

Line 5: Read in inches of mercury and recorded. Pressure is below atmospheric so sign is negative.
–7.9

Line 6: Calculated.
line 6 = 1.131 (line 5)
–9.0 = 1.131 (–7.9)

Line 7: Measured prior to test and constant for all readings. Gage line is air filled so correction equals distance between gage tap and datum line of pump. Gage is above datum so correction is positive.
+0.3

Line 8: Calculated.
line 8 = line 6 + line 7
–8.7 = –9.0 + 0.3

Line 10: Discharge gage read and recorded.
72.6

Line 11: Gage has been calibrated prior to test, correction is from calibration curve.
–2.2

Line 12: Calculated.
line 12 = line 10 + line 11
70.4 = 72.6 + (–2.2)

Line 13: Calculated.
line 13 = 2.31 × line 12
162.7 = 2.31 × 70.4

Line 14: Measured prior to test and constant for all readings. Gage line is filled with water so correction equals distance from center line of gage to datum line. Gage is above datum so correction is positive.
+1.6

Line 15: Calculated.
line 15 = line 13 + line 14
164.3 = 162.7 + 1.6

Line 17: From table of constants (p 142) for 16 × 14 pump
36,250,000

Line 18: Calculated.

$$\text{line 18} = \frac{(\text{line 3})^2}{\text{line 17}}$$

$$1.9 = (8350)^2/36{,}250{,}000$$

Line 20: Calculated.
line 20 = line 15 – line 8 + line 18
174.9 = 164.3 – (–8.7) + 1.9

Line 22: Measured and recorded.
1180

Line 23: Calculated.

$$\text{line 23} = \frac{\text{line 20} \times \text{line 3}}{3960}$$

$$369 = \frac{174.9 \times 8350}{3960}$$

Line 24: Calculated.

$$\text{line 24} = \frac{\text{line 23} \times 100}{\text{line 30}}; \quad 72 = \frac{369 \times 100}{513}$$

Line 25: Calculated.

$$\text{line 25} = \frac{\text{line 23} \times 100}{\text{line 32}}$$

$$78.3 = \frac{369 \times 100}{472}$$

Line 26: Measured, averaged and recorded.
442

Line 27: Measured, averaged and recorded.
575

Line 28: Measured and recorded.
0.87

Line 29: Calculated.

$$\text{line 29} = \frac{(\text{line 26})\ (\text{line 27})\ (\text{line 28})\ (\sqrt{3})}{1000}$$

$$383 = \frac{442 \times 575 \times .87 \times 1.732}{1000}$$

Line 30: Calculated.
line 30 = line 29 × 1.341
513 = 383 × 1.341

Line 31: Motor efficiency from motor manufacturer's data, as a function of line 30, or as a constant.
92%

Line 32: Calculated.

$$\text{line 32} = \frac{\text{line 30} \times \text{line 31}}{100}$$

$$472 = \frac{513 \times 92}{100}$$

Line 34: Calculated for 1200 rpm

$$\text{line 34} = \text{line 3}\left(\frac{1200}{\text{line 22}}\right)$$

$$8490 = 8350\left(\frac{1200}{1180}\right)$$

Line 35: Calculated for 1200 rpm.

$$\text{line 35} = \text{line 20}\left(\frac{1200}{\text{line 22}}\right)^2$$

$$180.8 = 174.9\left(\frac{1200}{1180}\right)^2$$

Line 36: Calculated for 1200 rpm.

$$\text{line 36} = \text{line 32}\left(\frac{1200}{\text{line 22}}\right)^2$$

$$496 = 472\left(\frac{1200}{1180}\right)^2$$

Line 37: Calculated for 1200 rpm as a check on lines 34, 35 and 36, and should agree with line 25.

$$\text{line 37} = \frac{\text{line 34} \times \text{line 35} \times 100}{\text{line 36} \times 3960}$$

$$78.3 = \frac{8490 \times 180.8 \times 100}{496 \times 3960}$$

centrifugal pump field-test data and calculating results

is pressure preceding nozzle, psi. Fire nozzles do a good job.

Weirs are also an acceptable method of measuring flow. They do a top job where you're pumping water into an open culvert or irrigation ditch.

Pitot tubes can be used to measure flow through pipes but they're impractical for most pump-testing installations. Substantial amount of precise testing is required in making each flow traverse. And flow must be maintained at constant rate in order to get reliable results.

Pressure. Measurement of pressure comes next. You can

Here are formulas you'll need to run pump tests

FLOW

For volumetric tanks:

$$Q = 448.8 \times A \times Z/T \quad (1)$$

For weighing tanks:

$$Q = 7.2 \times W/T \quad (2)$$

With hot water:

$$Q = (7.2 \times W)/(T \times S) \quad (2a)$$

With meter:

$$Q = (K \times C)\frac{D^2_2}{\sqrt{1 - (D_2/D_1)^4}}(\sqrt{2 \times g \times h}) \quad (3)$$

Meter using mercury manometer, measuring flow of cold water:

$$Q = \frac{20.11 \times C \times D^2_2}{\sqrt{1 - (D_2/D_1)^4}}(\sqrt{h_{HG}}) \quad (3a)$$

Meter using mercury manometer, measuring water flow of any specific gravity:

$$Q = \frac{20.11 \times C \times D^2_2}{\sqrt{1 - (D_2/D_1)^4}}(\sqrt{h_{HG}/S}) \quad (3b)$$

HEAD

Converting manometer reading to head:

$$h = (h_g \times w_g)/(12 \times 62.3) \quad (4)$$

Converting mercury manometer reading, in inches, to feet of head:

$$h = 1.131 \times h_{HG} \quad (4a)$$

POWER

Power input to an ac, 3-phase motor:

$$kw = (volts \times amps \times power\ factor \times 1.732)/1000 \quad (5)$$

Power input from disk of a watt-hour meter:

$$kw = (N/T) \times (3600/1000) \times K_h \quad (6)$$

(K_h is stamped on meter face)

Power input from disk of a watt-hour meter using potential and current transformers:

$$kw = (N/T) \times (3600/1000) \times K_h \times C.T. \times P.T. \quad (6a)$$

where

C.T. = current transformer ratio
P.T. = potential transformer ratio

Power output:

$$bhp = 1.341 \times kw_{input} \times E_m \quad (7)$$

WATER HORSEPOWER

Water at 68 F (accurate from 32 to 100 F):

$$whp = Q \times H/3960 \quad (8)$$

Liquid of any specific gravity:

$$whp = Q \times H \times S/3960 \quad (8a)$$

SPEED CORRECTIONS

General formula:

$$n_1/n_2 = Q_1/Q_2 = (H_1/H_2)^{1/2} = (bhp_1/bhp_2)^{1/3} \quad (9)$$

Correction for flow:

$$Q_1/Q_2 = n_1/n_2 \quad (9a)$$

Correction for head:

$$H_1/H_2 = (n_1/n_2)^2 \quad (9b)$$

Correction for power:

$$bhp_1/bhp_2 = (n_1/n_2)^3 \quad (9c)$$

Velocity head constants for common pump sizes,

in the formula: $h_v = \frac{Q^2}{K}$

Pump suction diameter, in.	Pump discharge diameter, in.	Velocity head constant, K
2	1	413
2	1½	2,830
2½	2	10,600
3	2	7,700
3	2½	29,300
4	2	6,580
4	3	45,500
5	3	36,000
5	4	167,000
6	3	33,250
6	4	123,000
6	5	435,000
8	4	105,800
8	5	285,000
8	6	733,000
10	4	101,200
10	5	257,000
10	6	575,000
10	8	2,680,000
12	8	1,970,000
12	10	7,500,000
14	8	1,768,000
14	10	7,400,000
14	12	17,350,000
16	10	4,550,000
16	12	11,700,000
16	14	36,250,000
18	16	67,000,000
20	18	118,600,000
24	20	119,000,000
30	24	217,000,000
36	24	160,000,000
36	30	606,000,000

Constants for other sizes of pumps can be calculated from

$$K = 385.6\Big/\left(\frac{1}{D^4_d} - \frac{1}{D^4_s}\right)$$

This formula is derived from:

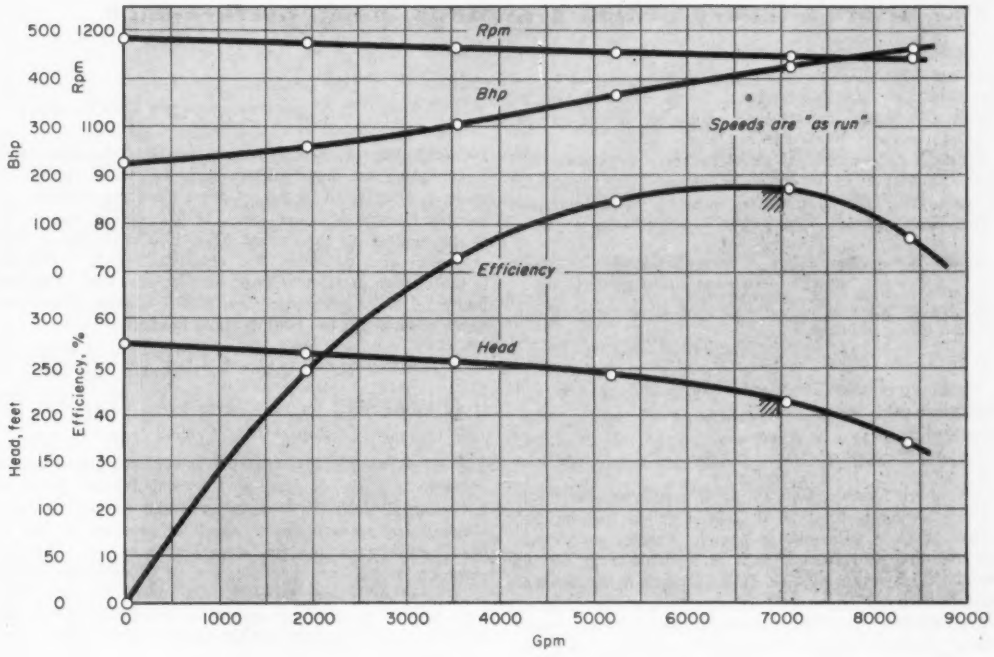
$$h_v = \frac{V^2_d}{2g} - \frac{V^2_s}{2g}$$

Measured pressures must be

use either a bourdon gage or U-tube manometer to measure water pressures. For accurate results, manometer gets the nod below 10 psi and is often used up to 30 psi.

You'll also need to correct pressures to a common datum plane, usually the horizontal center line of the pump, (see p 139). If instruments are portable, mounting the gages at the datum line or some other common line can often cancel out the elevation correction, eliminate extra figuring.

Manometers usually don't require calibration, but if you plan to use bourdon gages, they should be calibrated. Another alternative: Use test gages of known accuracy. Permanently mounted gages aren't necessarily accurate for



Plotting test results shows pump performance over full range

Once you've taken test data and calculated results, plot curves such as those above: Head vs flow, efficiency vs flow, pump power input vs flow, etc.

Big advantage of plotting test points on a graph: You get a continuous picture of how pump is performing over its entire range. If any point shows up as a sharp break from other points on the curve, chances are it's an incorrect test point—either in taking of the data or in figuring results. Such errors are tough to spot by simply inspecting data.

In addition to the curves, above, you can also plot: (1) kilowatt-hours vs flow (2) $$-per-day power cost vs flow (3) time to fill reservoir vs height of reservoir (4) combined head-capacity characteristics of several centrifugal pumps in series or in parallel

corrected to common datum—usually the pump's horizontal center line

centrifugal pump test purposes unless you've calibrated them.

To measure pressure you need two gage connections; one at the suction, the other at the discharge. Taps belong either at the pump flanges or adjacent to them. Holes must be at least ⅛ in., drilled to the water passage and free from burrs. Connect the gages with flexible tubing and be sure to provide vent cocks close to the gage.

Most common U-tube manometer uses mercury as the balancing fluid. If measured pressure is less than atmospheric, vent the manometer before taking reading (to insure a dry line). Next, check top surface of the mercury. It should be free of water or dirt. After reading the manometer in inches, convert to feet of head by using the formula:

$h = h_g \times w_g/(12 \times 62.3)$, or for mercury and cold water,

$h = 1.131\ (h_{HG})$

To this figure we add the distance between the tap and the datum line. Total is the *static suction lift* in feet of water. If tap is above the datum line, subtract this distance. Convenient practice when suction is positive is to allow the gage line to fill with water, filling the connected side of the manometer on top of the mercury.

You can use same formula to convert manometer reading to feet of head; but elevation correction is from the point where water joins mercury, to the datum line. If this point

Here's theory behind centrifugal pump performance

The theory of how a centrifugal pump operates ties in closely with actual performance. Here we briefly review some of the more important fundamentals.

Basically, the centrifugal pump converts mechanical energy—the output of a motor or engine—into hydraulic energy in the form of increased pressure of the pumped liquid. Simply stated:

Energy in water at suction + energy input = energy in water at discharge + losses

Total energy per unit of water flowing is constant at any specified time and is equal to:

$$H = h_g + V^2/2g + Z$$

If we multiply this formula by the pounds per second flowing, we get:

$$0.00223 \times Q \times w \times H = 0.00223 \times Q \times w\,(h_g + V^2/2g + Z) = 550 \times whp$$

In the above formula, $0.00223 \times Q$ represents the cu ft per sec flowing in the pipe if Q is in gallons per minute. $0.00223 \times Q \times w$ is equal to pounds of water per second. The pressure read from a gage or manometer in feet of head is h_g. $V^2/2g$ is part of the head that's in the form of velocity energy. Z represents the elevation, above or below any specified level. We need to include this last factor because energy of liquid in a pipe depends on pipe elevation. *Whp* is the actual horsepower in the water.

Here's an example: Water quantity flowing into the suction and out the discharge is constant. Pressure change you read on the gages is the increase in static pressure. Velocities in suction, discharge pipes are usually different because of smaller diameter discharge. Since elevations of the two gages may be different, their distances from the reference elevation may vary. If we subtract total energy in the suction from the total energy in the discharge, we get the increase in energy across the pump:

$$0.00223 \times Q \times w\,(h_{gd} + V^2_d/2g + Z_d) - 0.00223 \times Q \times w\,(h_{gs} + V^2_s/2g + Z_s) = 550 \times whp$$

If we rewrite this formula for water at 68 F:

$$(h_{gd} + Z_d) - (h_{gs} + Z_s) + \left(\frac{V^2_d - V^2_s}{2g}\right) = \frac{550 \times whp}{0.00223 \times Q \times w} = 3960 \times whp/Q$$

Lefthand part of the formula is the *total dynamic head.* The reading on the discharge gage converted to feet of water and corrected to the reference elevation (usually the pump's horizontal center line) is $h_{gd} + Z_d$; $h_{gs} + Z_s$ is the reading on the suction gage, also converted to feet of water and corrected for elevation. $(V^2_d - V^2_s)/2g$ is the change in velocity head, in feet of water. You can figure velocities from pipe sizes and flow rates. The three terms combined is the total dynamic head, H:

$$H = (h_{gd} + Z_d) - (h_{gs} + Z_s) + \left(\frac{V^2_d - V^2_s}{2g}\right)$$

If we substitute H for these three terms, we get:

$$whp = H \times Q/3960$$

The above formula says that the horsepower added to the water by a pump, is equal to the total dynamic head, in feet, multiplied by the flow, in gpm, and divided by 3960.

Pump engineers prefer to speak of pressure in feet of head rather than psi for several reasons. It simplifies elevation corrections. The pressure of a centrifugal pump at a given speed and capacity, is a specific head, in feet, regardless of temperature or specific gravity of the liquid. Here's a simple formula you can use to convert from psi to feet of head:

$$h_g = 144 \times p_g/w, \text{ and } p_g = h_g \times w/144$$

Not all power delivered to the pump shaft becomes useful pump output. Some of it is wasted as heat in the bearings, packing and shaft sleeves. Still more is lost as friction between pump and water, or friction in the water itself. Leakage from the discharge back to the suction, through impeller rings and breakdown bushings also accounts for power losses. Pump efficiency relates pump-power input to output:

$$E_p = whp \times 100/bhp$$

Where *whp* is power output and *bhp* is power input. Efficiency is the measure of how well a pump is performing at any specified capacity. Figuring efficiency is one big reason for running pump field tests.

---

is above the datum, correction is positive; below the datum, correction is negative.

One of the simplest, most accurate ways of measuring relatively low water-pressure differences is with a water manometer. You can make a temporary test instrument from transparent plastic hose. If pressure is positive, attach one end of hose to the pipeline. Leave other end open to atmosphere and support it above the tap. Vertical distance, in feet, from water level in the hose to the datum line is the head, in feet of water. No corrections or calculations are necessary. If pressure is less than atmospheric, drop the line to form a U-shape from the tap. With the other end open to atmosphere, purge the tap side of all air. Vertical distance, in feet, from the water level to the datum line is the head in feet of water; this time negative.

Gage snubbing dampens out slight line and gage pulsations. Commercial snubbers generally aren't used for test purposes; a better method is a small gage cock which you can adjust manually. This setup allows a minimum restriction and still keeps the gage "alive."

Power. Equally as important as the pump's hydraulic characteristics is its power input—kilowatts to a motor, fuel to an engine, steam to a turbine.

Measuring fuel quantity is a simple matter, and although a breakdown of losses between driver and pump isn't always possible, you can figure the overall efficiency of the driver

and pump. We often call this figure the "duty." This info is important because it's an accurate gage of operating costs.

Motors, today's most common pump drive, are well adapted to testing. You can measure power input with a voltmeter, ammeter and power-factor meter. Then use formula (5), p 142, if motor is 3-phase, ac. Alternative is to measure motor power input with a watt-hour meter and time the disk with a stopwatch. Figure power from formula (6) or (6a).

Another portable instrument available in almost every plant, or which you can generally borrow from the local utility company, is the industrial test analyzer, including a voltmeter, ammeter, power-factor meter and watt meter, all built into a single case.

After you've measured power input, next step is to measure power output. This, of course, depends on motor efficiency. Here's a simple formula you can use:

$$\text{bhp}_{\text{output}} = \text{hp}_{\text{input}} \times E_m \text{ where,}$$
$$\text{hp}_{\text{input}} = \text{kw}_{\text{input}} \times 1.341$$

Although you can get motor efficiency from tests of motor losses, an easy and practical method is to use manufacturer's guaranteed motor efficiencies.

Engines, both diesel and gasoline, drive many of today's centrifugal pumps. While measuring their fuel consumption is relatively easy, accurately figuring horsepower output is tough. A practical approach: Measure fuel consumption carefully, with the engine running at rated air-inlet conditions, then plot fuel consumption vs pump output. Best way to plot results depends on test conditions.

Steam turbines are finding increased use for many pumping jobs. Much like the engine, measuring power output in brake horsepower, isn't easy. But, many installations now have steam flowmeters; and while you can't measure horsepower output of the turbine with them, you can figure turbine performance in pounds of steam per foot pound of work:

$$\text{Duty} = W_w \times H \times 1000/W_s$$

Duty here is for 1000 pounds of steam. W_w is the number of pounds of water pumped per hour. H is the total dynamic head. W_s is the number of pounds of steam used per hour. Knowing the cost per pound of steam, you can convert "duty" to unit operating cost.

Speed. Pump flow rate against a specified head depends, in part, on its speed. Thus, it's important to find rpm of pump you're testing. Pump manufacturers usually draw their test curves on the basis of the contract speed. If field-test speeds vary, you'll need to correct the head, capacity and brake horsepower.

Synchronous-motor speed on utility-generated or paralleled power can be considered equal to namplate speed. But induction motor speed changes with load. At low load, speed approaches synchronous. At full load, speed drops off somewhat. To check motor speed, use a hand tachometer off the outboard end of the motor or pump shaft. Hand-held counter and stop-watch also does the job. Be sure to check speed at each test point.

Engine and turbine speeds are also variables. If these drives connect to a step-up or reduction gear, don't forget to account for gear ratio.

After finding speed at each test point, plot speed against flow. On the curve, p 143, head and capacity are based on speeds "as run." But you may want to find equivalent performance at same speed as manufacturer's test speed. Or, you might choose a different speed in order to figure pump characteristics with a different type of driver. In the sample test, p 140, we corrected data to 1200 rpm to find performance of the pump coupled to a synchronous motor.

FIGURING RESULTS

After completing measurements you can plot a series of curves from the calculated results. Flow Q is the actual flow, in gpm. Total dynamic head is:

$$H = h_d - h_s + h_v$$

Velocity head h_v is the change in measured head due to velocity difference between suction and discharge pipes. If pipes are same size, velocity head is zero. But suction pipe is usually larger than discharge. Formula for velocity head is:

$$h_v = Q^2/K$$

You can find K in table, p 142. Caution: If you measure pressure at a point whose pipe diameter is different than that of suction or discharge, base velocity head on diameter at that point.

Water horsepower is the product of total head and flow, divided by 3960. Formula is exact for water at 68 F and is reasonably accurate from 32 F to 100 F. Above 100 F, multiply the formula by the specific gravity of liquid you're pumping, see formulas (8) and (8a), p 142.

Pump speed doesn't actually enter into the figuring unless you want to see results for different drivers or want to correct the test to manufacturer's test speed. To correct for a speed change, first figure the test "as run." Next, modify the flow, head and the *bhp* according to formula:

$$n_1/n_2 = Q_1/Q_2 = (H_1/H_2)^{1/2} = (bhp_1/bhp_2)^{1/3}$$

You can also break this equation down into three separate corrections for flow, head and power, see formulas (9a), (9b) and (9c), p 142.

Efficiency remains unchanged for speed correction of 10 to 20%. So you can use efficiency at each point from the original speed. Refiguring efficiency from corrected results is a good check on the corrections themselves.

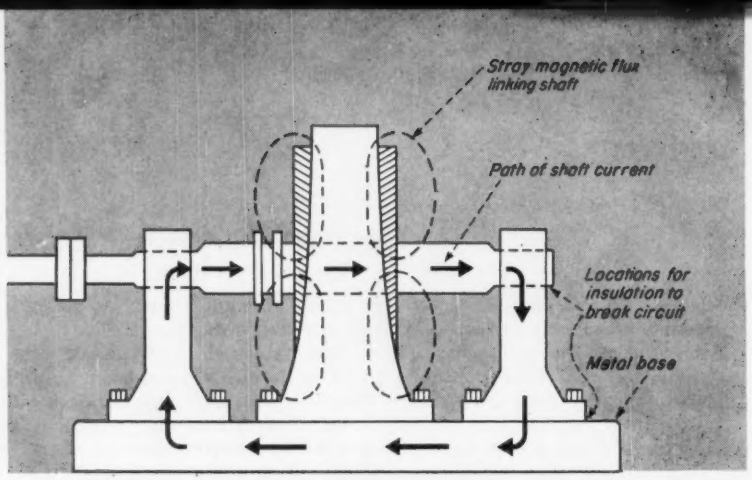
PLOTTING RESULTS

Common practice shows pump performance by plotting all results on the vertical scale, against flow on the horizontal scale: Head vs flow, efficiency vs flow, *bhp* vs flow, etc, p 143. The curves help show up incorrect test points, give a continuous picture over the entire operating range from data on only five to ten points.

If driver is variable speed, plot several different speeds covering driver's full range. Such curves give you a complete picture of speed and power required to fill each head and flow condition.

Other useful curves that you can plot from the basic curve are: (1) kilowatt-hours vs flow (2) $$-per-day power cost vs flow (3) time to fill a reservoir vs height of reservoir (4) combined head-capacity characteristics of several pumps in series or parallel. Such info is often valuable in operating, maintaining and planning a pump installation.

By PAUL S NULL*



SHAFT CURRENTS in large rotating machinery are generated by shaft cutting the stator leakage flux. Current follows path through bearings, pedestals and base

Motor shaft currents can be important

► UNEXPLAINABLE sleeve - bearing trouble—pitting and blackening of babbitt—may be caused by an electric current passing between shaft and bearing. This shaft current produces a minute electric arc at points where oil film breaks down. If these tiny hot spots reach melting point of babbitt alloy, pitting of the bearing lining results. Both journal and lining take on a frosted appearance in the early stages; as the process continues, surface irregularities become more pronounced. Advanced stages of shaft-current activity are characterized by blackening of the oil by carbon residues of decomposition.

Voltages induced in the shafts of small industrial motors and generators are usually so small as to go unnoticed. In large rotating machines, such as turbine-generators and synchronous motors, however, currents circulating through the mechanical members may be considerable if preventive measures are not taken. Path where circulating current is most likely to occur is through motor shaft, bearing pedestals or brackets and metal base.

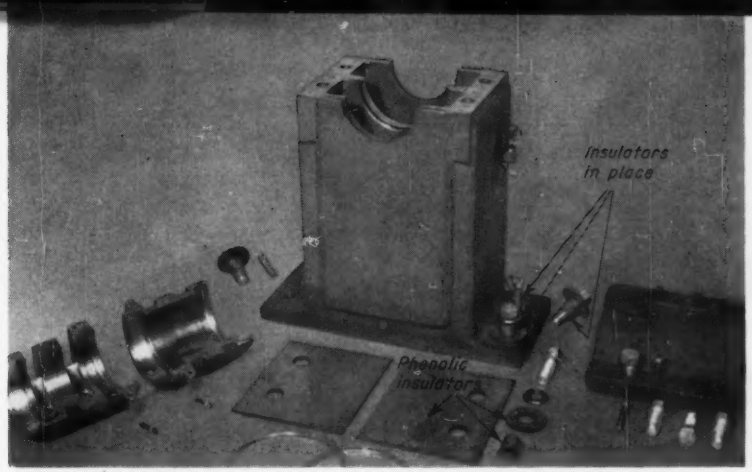
Manufacturers insert insulation into this circuit, preventing current flow. This accounts for the occurrence of insulation (generally a phenolic laminate) in parts of machines where it apparently serves no purpose. In horizontal equipment with pedestal-supported bearings, it may appear as a sheet between a pedestal and the base. Since insulation of one pedestal of a machine having two pedestals is sufficient to open the circuit, the other pedestal may not be insulated. This is advantageous where it is desired to keep all metal structural parts at ground potential. Another technique is to build a phenolic insert into the bearing sleeve in such a manner as to insulate the sleeve from the housing, photo facing page.

Shaft-voltage magnitude depends on design of the magnetic circuit, which explains why one machine requires shaft-current insulation while another machine of the same rating does not. Magnetic leakage flux may occur where it can be cut by the rotating shaft, and in consequence a voltage is induced in the shaft. Modern ac motors, generators and synchronous condensers have stator cores made of tightly packed, thin steel laminations. In smaller sizes, these laminations are punched in one piece, which helps keep down the leakage flux. As machine size increases, however, manufacturing convenience requires that segmental punchings be used, creating small air gaps. Sometimes the stator is too large to be shipped as a single unit; the necessary two-piece construction introduces two definite breaks in the core. This often is the case in the construction of large, low-speed waterwheel generators. Regardless of why they are in the stator core, the joints, as well as unavoidable irregularities in the core material, can combine to divert a portion of the magnetic flux from the normal stator and rotor paths. If the unbalance introduced by the joints, etc, is great enough, a weaving difference flux reaches beyond the rotor core to link the shaft, and voltage is induced in it.

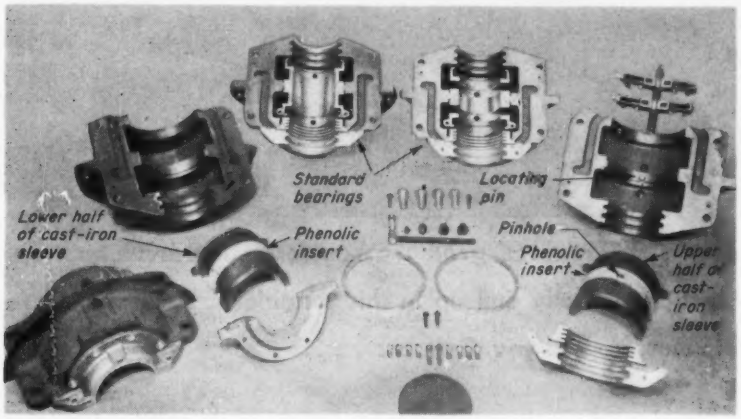
Ac machines are not the only offenders in this respect. Because their solid ring-type stators are sectioned and bored bolts, dc machines also produce significant shaft voltages.

By considering relation of stator-core joints to number of stator poles, engineers can predict whether machine has a shaft voltage of sufficient magnitude to cause breakdown of oil films. Appropriate standard insulating procedures are applied in all those cases where either experience or computations indicate that trouble might occur. The necessity for insulation against shaft currents is not a reflection on the quality of the machine's design; other

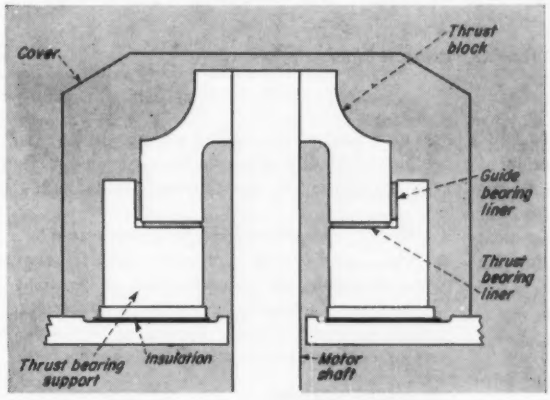
*Formerly with The Elliott Company



PEDESTAL-SUPPORTED horizontal machines have pedestal insulated from the base. Phenolic-laminate plates are used with cylinders and washers for bolts and dowels



BRACKET-SUPPORTED horizontal machines include insulation in bearing design. Phenolic inserts keep both halves of bearing sleeves from contacting the housing



VERTICAL-MOTOR bearing is insulated from motor frame by phenolic-laminate sheet, securely held to transmit thrust

design considerations may make the type of core used advisable. Shaft currents can result from other causes than core joints and irregularities. Measures taken to prevent them do not involve methods of insulation described.

Maintenance precautions are necessary where a machine has shaft-current insulation so insulation will not be shorted out. Maintenance personnel should note these check-off points for motor shaft current insulation:

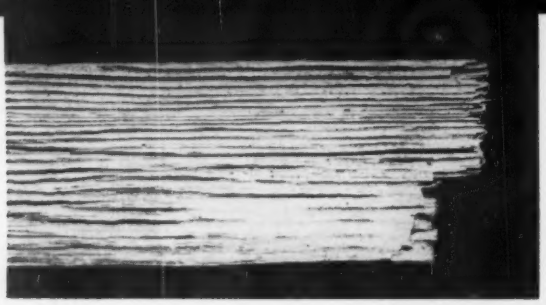
1. Keep dirt, oil or water from collecting around the insulating sheets in vertical machines or in machines with pedestal-supported bearings.

2. Never paint over the insulation. Paint may be a sufficiently good conductor to provide a path for the shaft current. Cases have been known where serious damage to bearings occurred when paint with a metallic base was applied indiscriminately at the bottom of insulated pedestals.

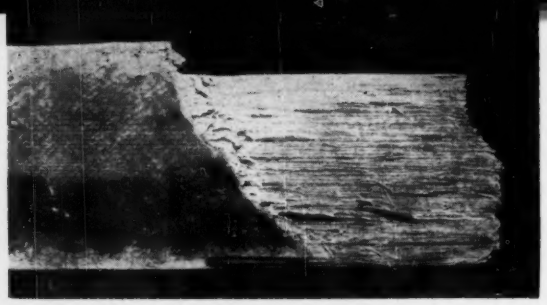
3. When reassembling a machine, make sure all insulation is in its proper place. Omission of a single phenolic washer, cylinder or fitting defeats the purpose of the insulation. It's not easy to measure shaft currents on the job, so it's essential to be visually certain current can't flow. If insulators are crushed or damaged, replace them with new ones of the same or equivalent material.

4. When devices which might by-pass shaft-current insulation (for example, bearing temperature relays or centralized lubrication systems) are installed after the machine leaves the factory, competent engineering supervision should be employed. Insulating material may be needed in the auxiliary equipment comparable to that used in the machine.

Diagnosing shaft-current troubles in machines without original insulation is very tricky. It's best to consult the manufacturer's engineers in such cases.



Delignification . . .



fungus attack and . . .

salt deposits on wood cooling-tower slats are three good reasons for topnotch water treatment. Fortunately, cooling towers don't usually end up in this condition. But it's good insurance to check for trouble symptoms. To aid you, here are . . .

18 Q & A's on treating cooling water

By R H MARKS, *Assistant Editor*

1 Is there an ideal treatment for all cooling waters?

A Economics plays an important role in both selection of cooling-water systems and methods of water treatment. It's *possible* to prescribe an ideal water for each cooling job, but equipment and chemical cost is out of the question for most installations. So treatment must be tailored to fit the size and type of cooling-water systems currently in use.

COOLING SYSTEMS

2 What are the main types of cooling systems?

A The two main classifications are "once through" and "circulating." In the simple once-through system water passes through the heat-exchange equipment only once. It is increased in temperature about 20 F before going to waste.

Circulating systems are more complex. Cooling water also passes through a heat exchanger or other apparatus where cooling occurs. Temperature increases from 6 to 20 F. Heated water is then cooled in another exchanger using an external cooling medium such as an air-cooled radiator.

3 Is there a trend to the use of circulating systems?

A Since the once-through system calls for an almost unlimited supply of cooling water, today's trend is toward the use of circulating systems where the water is cooled for re-use. Cooling is brought about in the open type by actually evaporating a part of the cooling stream. In a closed system the cooling is usually done in an air-cooled radiator. A separate circulating or once-through setup can also be used.

4 Where are open and closed systems used?

A Open type is most frequently used for cooling water in chemical plants, oil refineries and power-plant condensers. Closed system is usually limited to jobs where the quantity of cooling water isn't large. Typical applications include compressor cooling jackets and diesel engines.

EXCESSIVE SCALING

5 What causes scale formation?

A Most common type scale found in heat-exchange equipment is calcium carbonate formed by the breakdown of calcium bicarbonate in the cooling water at high temperatures. Magnesium compounds and calcium sulfate are rarely the cause of scale in cooling systems. Scaling is affected by temperature, rate of heat transfer, calcium, magnesium, silica, sulfate and alkalinity concentrations and the pH.

6 How is the Langelier index used?

A Langelier index measures the tendency of calcium carbonate to precipitate from water under given conditions of calcium hardness, alkalinity, pH, temperature and total dis-

solved solids. Charts, nomographs and special slide rules can be used to quickly calculate this index for any water supply when the analysis is known. Positive index means water has a tendency to deposit scale while a negative index shows a tendency to dissolve scale and corrode. Note that index does not measure amount or rapidity of scaling. This depends only on calcium carbonate or bicarbonate content.

Index is decreased by reducing calcium hardness, calcium bicarbonate, pH or a combination of all three. Total dissolved solids has a relatively minor effect on the index.

Blowdown can be used to reduce the calcium and alkalinity in the circulating water. But it increases makeup and is seldom used as the only means of control.

Other treatment methods used to adjust the analysis include: cold-lime softening, usually followed by an acid feed for the adjustment of pH and alkalinity; partial zeolite softening with hard water by-pass, also followed by an acid feed if needed. Some moderate-hardness high-alkalinity waters can be handled with an acid feed alone.

7 What is the "controlled scale" method?

A It is a method of keeping index of the circulating water slightly positive, say in the range of 0.5 to 1.0 at the highest temperature in the system. This is usually enough to insure deposit of a thin impervious layer of calcium-carbonate scale on the surfaces of the cooling-water system. Careful adjustment of pH, alkalinity and calcium is needed to keep the desired index and protect the system against the ravages of excess scaling and corrosion.

8 What is the role of surface-active chemicals?

A Surface-active materials prevent crystal growth and therefore scale formation. They increase the solubility of scale-forming salts so precipitation doesn't occur when solubility limits are exceeded. Chemicals used for this purpose include special types of phosphates, tannins, lignins, etc. They can handle the job of scale prevention alone and are also helpful in broadening the range of Langelier index control in the controlled-scale treatment.

CORROSION

9 How do you control cooling-water system corrosion?

A Corrosion inhibitors such as chromates, phosphates, silicates and alkalies are used. Anodic inhibitors of the chromate and phosphate type decrease metal attack. But if the concentrations are too high, pitting and tuberculation result. Use of chromate in combination with phosphate has been successful in controlling pitting, tuberculation and other metal losses from corrosion, and dosages are at economical levels.

Since O_2 and CO_2 are primary cause of corrosion one of the more direct treatments is deaeration. With a vacuum deaerator, oxygen can be reduced to as low as 0.1 ppm depending on water temperature and equipment design.

SLIME AND ALGAE

10 What causes slime and algae to form?

A Algae growths are composed of millions of tiny plant cells that multiply and produce large masses of plant material in a short time. Slime growths are a gelatinous mass of micro-organisms that cling tightly to secluded surfaces in the system, trapping organic and inorganic matter and debris along with scale-forming materials. Any appreciable buildup seriously interferes with heat-transfer efficiency.

11 What chemicals give effective treatment?

A Chemicals that prevent slime and algae troubles are those that exert a toxic action on the micro-organisms.

Chlorine is fairly general in toxicity for most bacteria, algae and protozoa, but continuous application in a once-through system is too expensive. Intermittent treatment gives good results at much more reasonable cost.

Copper sulfate is toxic to simple algae, but is less toxic to slimes. Use is limited because copper sulfate precipitates at a pH of 8.5 or higher. Phenolic and other quaternary ammonium compounds are also used. They have the advantage of resisting precipitation at high pH and are not removed from the system by aeration in the cooling tower.

12 Why is an intermittent feed best?

A Intermittent large doses of chemical rather than a steady feed of a much smaller quantity keep the micro-organisms from getting used to the treatment and building up an immunity to it. It also avoids the danger of a new strain of algicide- or slimicide-resistant bacteria developing.

13 How are accumulated slime and algae removed?

A Best way to get rid of these growths is by mechanical cleaning. In the case of algae the algicide may only loosen the growth enough to set it free in the system to plug lines and damage pumps. After the system is completely cleaned, start out on the right foot with a good chemical-treatment program to prevent future buildup of these growths.

WOOD DESTRUCTION AND DECAY

14 What causes cooling-tower wood destruction?

A This destruction is usually caused by one or a combination of: (1) chemical attack commonly known as delignification (2) mechanical rupture of wood cells from salt crystallization and (3) biological attack causing wood decay.

15 What is delignification and when does it take place?

A It is the removal of tannins, lignins and cellulose products from the lumber, leaving long stringy fibers with greatly reduced strength. It apparently occurs in the presence of high concentrations of sodium carbonate in the circulating water. Oxidizing agents like chlorine speed up the process.

16 Why are salt deposits harmful?

A Intermittent splashing on parts of the cooling tower produces concentrated salt deposits by evaporation. Salt-saturated water in these areas is absorbed by the wood. Then crystals form beneath the surface of the wood mechanically disintegrating it. Result is a mass of soft loose fibers susceptible to both chemical and biological attack.

17 What is fungus attack and how is it caused?

A It is a form of biological attack that is caused by micro-organisms that use the wood for food. These wood-destroying fungi reproduce by means of spores that are normally airborne and alight on the surface of the wood. The attack is not confined to any particular section or make of cooling tower. It is most noticeable in the mist sections and takes place on both the surface and the interior of the wood.

18 How do you combat fungus attack?

A Proper control of alkalinity, pH and solids content of the circulating water will go a long way toward preventing chemical attack on the wood. It will not *prevent* biological attack, but will decrease chances of damage from fungus.

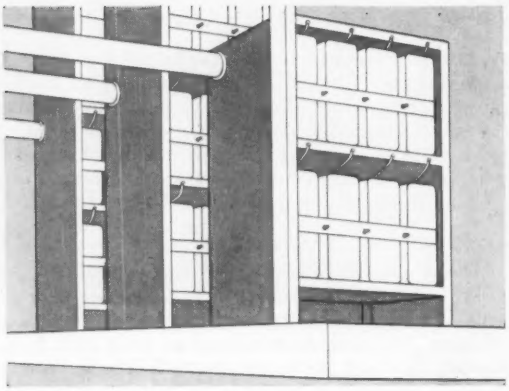
One preventive today is use of properly impregnated cooling-tower lumber. Chromated copper-arsenate salts show much promise for this. A different approach is to try to chemically destroy the fungi in the circulating water by treating with sodium pentachlorophenate, zinc sulfate, and sodium chromate. Use intermittent dosing. It is often effective to spray a concentrated solution of toxicant directly on the cooling-tower wood in those sections most likely to be attacked by the fungus, including tower mist areas.

Plant Electrical Fact File

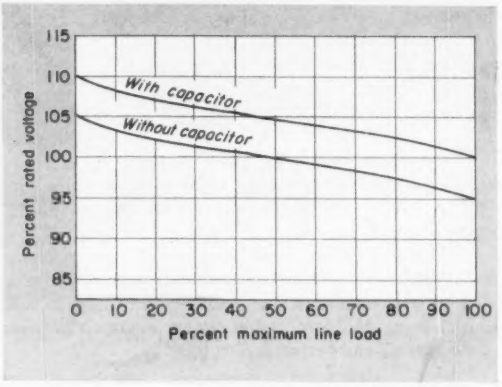
6 tips on pf capacitor care

NO. 20: CAPACITORS

By NORMAN PEACH, *Assistant Editor*

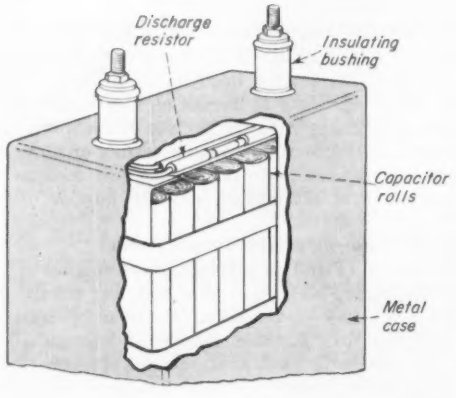


1 **INSPECT** and clean every 4 months; more often if in dirty spot. Check temperature; if above 55 C, look for cause. Make sure ventilation is not obstructed

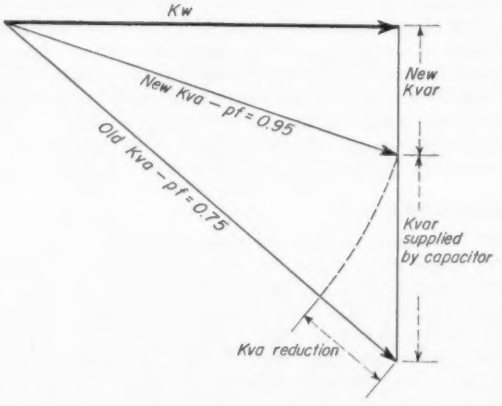


2 **OVERVOLTAGE** can occur on capacitors, especially if system has poor regulation. For short periods, 15% overvoltage is tolerable for 230-, 460-, 575-v capacitors; 10% for higher ratings. More than 5% average over 24 hours calls for remedy: (1) reduce circuit voltage (2) switch capacitors during the overvoltage periods

What power-factor capacitor does

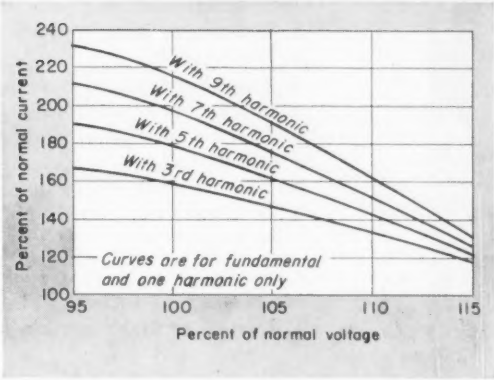


CAPACITOR rolls are made of two sheets of aluminum foil separated by insulating paper. Case is filled with insulating liquid, and then case is hermetically sealed



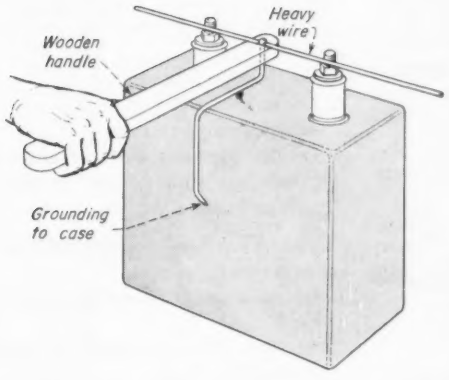
REACTIVE power (kilovars) is supplied by capacitor, cuts load kilovars by same amount, releasing some kva for useful work. Improved pf brings lower utility rate

► POWER-FACTOR CAPACITORS require so little attention that it's easy to forget about them entirely. A few simple routine checks are in order, however, to keep capacitors in reliable condition, avoid shutdowns.—*Prepared with assistance of General Electric Co*

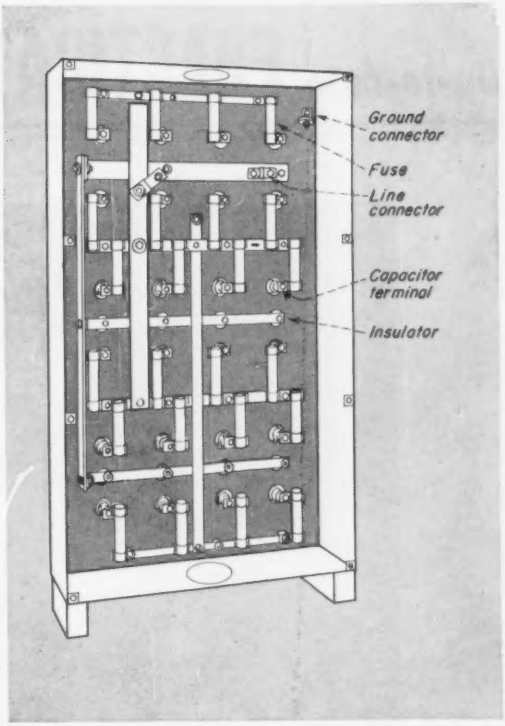


3 **CHECK KILOVARS** to be sure they don't exceed allowable 135% of rating, measuring with ammeter and voltmeter. Exceeding rating of all units in bank indicates harmonic currents, and study of system is advisable. Relocation of all or part of capacitors, or switching during high-current periods, may be a solution

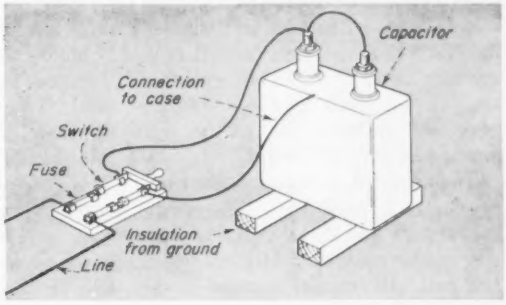
Be safe!



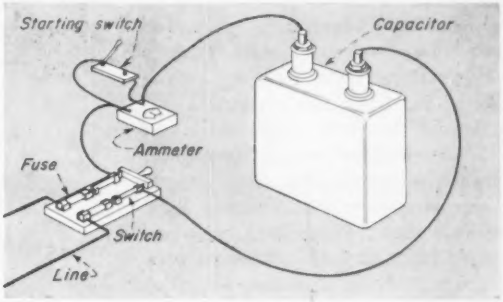
DISCHARGE capacitor before working with it: short terminals, ground to case. Built-in resistor is intended to discharge to 50 v in one minute



4 **FUSES** should be checked at least four times a year. *Know where each is,* have replacements (165% to 235% of capacitor amps). Check switch contacts, too



5 **INSULATION TEST,** if capacitor appears defective, is simple with test hookup above, at line voltage. Use circuit breaker for hv, or special tester if available



6 **CAPACITOR TEST,** where normal current = rated kva × 1000 ÷ rated voltage. High current may be harmonic; a short blows fuse; low current is an open

Up-to-date PRACTICAL IDEAS *to lick some of your*

Now, ultrasonics helps overhaul meters

Ultrasonic cleaning helps you salvage many types of meters and similar devices. For instance, overhauling gas and other types of demand meters—giving them a new look—has improved revenue for utility and fluid processing industries.

Thus cleaned, meters are more accurate and sensitive. Also, clean carburetors and diesel-injection nozzles operate more efficiently and waste less fuel. Ultrasonic cleaning is especially handy when replacement parts have to be shipped long distances, or unit is so old that components are no longer available from stock.

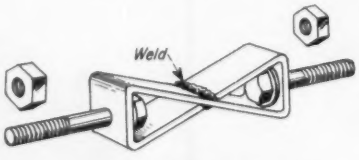
Ultrasonic generator, photo, is used with tank-transducer. Tank is 7½x9x13-in. high; cleaning area is 52 sq in. Generator converts 115-v, 60-cycle ac into high frequency (38kc) electrical energy. Transducer transmits mechanical vibrations of same frequency into cleaning fluid.

Cavitation, which is a continual rapid build-up and collapse of pressure, causes very intense scrubbing action. It actually blasts oil, grease, sludge, carbon, soot and other contaminants off of the meter. Because these high-energy pressure waves are transmitted in all directions, even those hard-to-clean areas are reached.

Blind holes, crevices, undercuts, threaded sections and the like are ideal dirt-catchers. Rolling-contact bearings are cleaned without disassembly.

A fluid often used for cleaning meters ultrasonically is trichlorethylene, at 110 to 140 F. But water solutions of alkaline detergents can also be used. Parts are hung on a wire, immersed in fluid with ultrasonic power turned on, and agitated for about ½ to 3 minutes. Tank transducer units hold up to 25 gallons of cleaning liquid.

Courtesy, Branson Ultrasonic Corp



Makeshift swivel buckle

Need a turn or swivel buckle in a hurry? You can easily make one from some flat stock and a couple of bolts, as shown in my sketch.

C H WILLEY, *Penacook, N. H.*

Main causes of turbine vibration

Bringing up to speed, vibration general—no special heat or noises:

1. Unbalanced rotating parts
2. Eccentric coupling
3. Sprung shaft
4. Sympathetic vibration of foundation or pipe connections
5. Improper heating or draining before starting
6. Water entering with steam
7. Bearings badly out of line (extreme case)

Vibration general—no special heating but jingling noises:

1. Internal packing rings binding on shaft
2. Revolving blades rubbing on stationary blades
3. Loose wheels
4. Sprung shaft (bad case)
5. Coupling trouble (unusually bad)

Vibration localized somewhat—local heating of shaft or bearings — no special noises:

1. Bearings don't fit shaft
2. Packing rings, if any, too small for shaft where trouble appears
3. Thrust-bearing trouble, such as insufficient or untrue surfaces
4. Oil supply cutoff

Vibration localized somewhat, with or without local heating, but jingling or pounding noises:

1. Bearing too large for shaft
2. Loose fitting pad or ball joint on self-aligning bearings
3. Oil film breaking down because of insufficient supply, low oil pressure or heating, etc

Vibration localized—no special heating or noises:

1. Loose bolts on bearing pedestal block
2. Spring in shaft where it goes through bearings
3. Flexibility of bearing pedestal because of unusual design or foundation peculiarities
4. Unbalance in minor rotating parts
5. Small bearing troubles in vicinity of vibration

operation and maintenance problems

STEVE ELONKA, *Associate Editor*

Vibration at full speed — vibration general—no special heating noises:
1. Water comes over with steam
2. Ball joint of self-aligning bearing so tight they can't align themselves with change of shaft position
3. Bearings out of line (bad case)

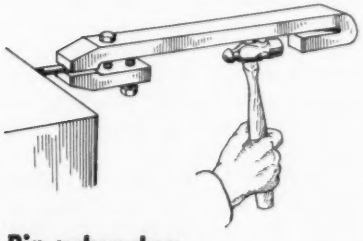
Vibration general—no special heating but jingling and pounding noises:
1. Rubbing between stationary and revolving blades
2. Loose wheel connections

Vibration somewhat localized—localized heating of shaft or bearings—no special noises:
1. Bearing pinching shaft
2. Oil trouble
3. Tight fit on ball joint of self-aligning bearing

Vibration somewhat localized, with or without local heating, jingling or pounding:
1. Bearing too large for shaft
2. Loose fit in ball joint of self-aligning bearings
3. Oil film breaking down from heating, lack of oil, deterioration of oil or low oil pressure
4. Rubbing of stationary and moving parts in locality of noise, heating
5. Unbalance, bad alignment, trouble in minor parts of machine

Vibration distinctly localized. No special heating—no special noise:
1. Loose bolts in bearing pedestal
2. Flexible bearing pedestal
3. Unbalance, poor alignment or bearing troubles in minor parts

P E MEREDITH, *Floral Park, N. Y.*



Pin extractor

Here's a handy tool for pulling dowel pins. Use tough steel, make extractor in any size suited for your shop.

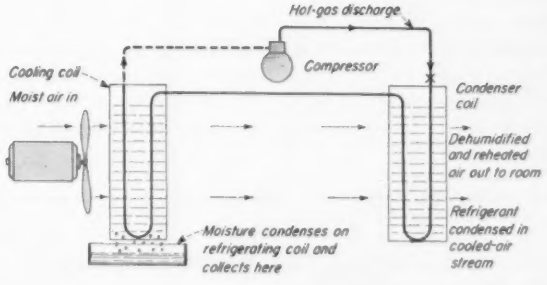
C H WILLEY, *Penacook, N. H.*

What would you have done?

A large iron foundry was receiving too many complaints about breakages of supposedly malleable castings. It turned out that the very brittle, freshly cast pieces looked exactly the same as those that had spent a week in annealing ovens. But careless workers were mixing them up. The assembly plant using the castings by the thousands was threatening to cancel its order if something wasn't done to weed out the unannealed pieces.

Castings had a small pin to guide positioning in assembly. Each piece was checked in a gage to make sure that pin wasn't warped. You can imagine the looks of surprise when one of the men pulled a Marmaduke stunt and suggested that the pin be cast at a slight angle. He explained that a small press for straightening it could be substituted for the gage. Then should an unannealed piece slip in, its pin would snap off in the press, and all the brittle castings could be instantly spotted and rejected. What would *you* have done?

G P PEARCE, *Albuquerque, N. M.*



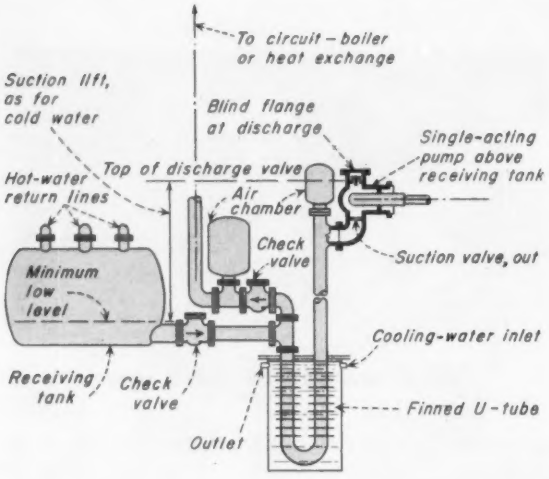
Now, excessive humidity damage is controlled

Humidity was excessive in a small control room, caused rusting as well as an uncomfortable environment. So we installed a standard domestic type dehumidifier unit, sketch, which dries the air by refrigeration. Now the room is comfortable and there is no further damage from excessive moisture in the air.

Another advantage: the condensed water is filtered. So we have an unfailing source of distilled water for batteries and other uses.

F WEHLAGE, *Fairport, N. Y.*

Begins on page 152



Here's how to pump hot water by cooling suction lift

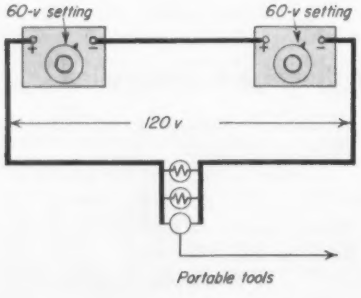
You can't always have a pump lift hot water at floated position needed for safety priming and working. My sketch shows a reciprocating pump which works like a popular piston pump. But piston has a liquid-extended part that's always cool.

Position of cooled part of liquid piston is under check-valve level and in contact with hot water. This prevents leaks past check valve (during stop period) from heating water. For minor density, hot water will remain above cold water.

Internal volume of finned-tube section has twice volume of water in alternate movement of piston. So during working condition, hot water moves to left and cold water to right of U-tube's low point. Increased surface of finned tube in contact with cooling water keeps tube cool. Heat cannot move by conduction along tube. Larger air chambers are needed for increased mass of the liquid part in alternate movement, also for the same piston pump without liquid piston. Heat lost by cooling water is negligible. Using reciprocating pumps in powerhouse is not too old-fashioned. They are preferred by the power man for ample load variation.

I found this device very practical, especially for hot-water circulation for process of single or multiple unity; also for continuous and very variable heating systems. It has important advantage of having pump far above low point of hot well.

J BORESTA, *West Englewood, N. J.*



Emergency power

Most plants have gasoline-driven welding machines. My sketch shows how two welders may be connected to provide 120-v dc, which will provide lights, heat or drive portable tools with universal motors, such as drills and skillsaws. This connection has been used by us for years.

T E MOYER, *Longview, Wash.*

Listen to warning noises to avoid trouble

Impeller shaft on our No. 2 double-suction 250-hp motor-driven centrifugal service-water pump failed about four years ago. Shaft fractured on motor side of impeller about midway between impeller and water gland, (inside pump casing). Shafts that fail usually have an irregular break, causing the driven end, or power end, to overtake the slower moving outer part of the broken shaft. Then two long ends of fracture soon come together, causing a violent outward thrust.

Something must give way. And since cast-iron won't bend or stretch, the casing breaks. We placed a larger diameter impeller in the pump. To get more water, we installed a 250-hp motor in place of the 175-hp motor. Several days before the break, we heard a slight rumble in the 12-in. discharge water line.

We checked the pump but sight and feel didn't show anything seriously wrong. So we let her roll. It would have been easy to switch over to another pump. Then if the rumble stopped, we'd have known there was trouble inside No. 2 pump.

Pump shaft finally did let go at about 2 am. Our low-pressure water alarm horn sounded and the shift engineer went to the basement to see if motor had tripped out. Motor was still running, but no pressure showed on gage. He pulled the switch, then put No. 1 pump on line.

After No. 2 pump was dismantled, shaft break showed an old crack, part way into shaft. We figured this had caused the shaft to spring or bend enough to cause a slight side wobble to the impeller, producing the rattle or rumble we heard for some time in the water lines.

Caution: If you hear a rumble, shut down immediately and open the pump. We replaced the broken shaft with a stainless-steel shaft and have had no trouble since.

A BELTON, *Montreal, Can.*

Turn page for more Practical Ideas ►

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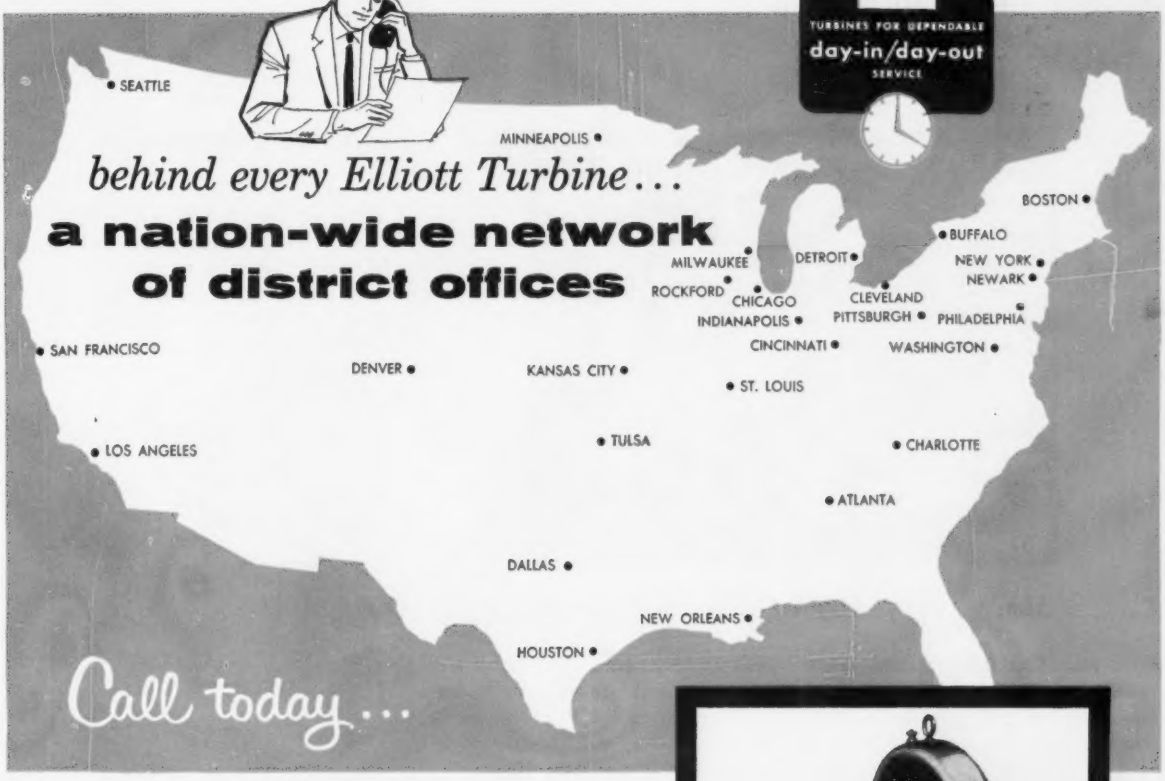

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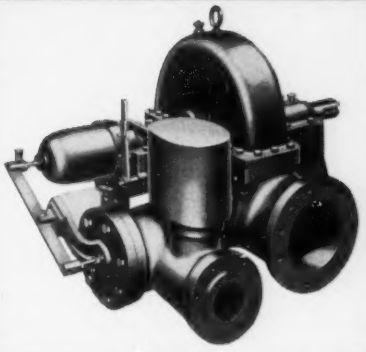

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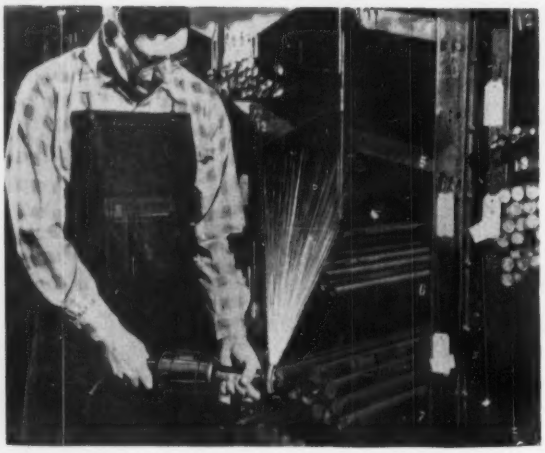
More PRACTICAL IDEAS

Begins on page 152



Simple, easy way to spark-test metal

Most maintenance mechanics spark test steel when selecting it for various uses. Easiest way is with a hand grinder. Grinder, above, is easy to handle, light weight and powerful enough to throw enough sparks to instantly establish the grade of steel under test. Grinder may also be used for other work, such as deburring, filing, smoothing welded seams, cleaning castings or for internal grinding. —*Courtesy, The Dunmore Company*

Winterize your hand (stirrup) extinguishers

You must prepare for cold weather by safeguarding the buckets, pails, barrels and hand pumps needed for fire extinguishing in unheated plant areas. Thoroughly inspect equipment when draining water at end of summer to detect serious rusting. Those found serviceable should be dried and coated on the inside with bituminous pitch which resists corrosive action of calcium-chloride solution. Pump pistons and packing glands must be cleaned and lubricated before cold weather starts.

Table for 2½ gallons of solution

Freezing temperature	*Water*	*Calcium chloride*	*Specific gravity*	*Degrees Baume*
10 F	2 gal	5 lb	1.139	17.7
Zero	2 gal	6¼ lb	1.175	21.61
10 – zero F	2 gal	7-6 oz	1.205	24.7
20 – zero F	2 gal	8 lbs 6 oz	1.228	26.9
30 – zero F	2 gal	9 lbs 2 oz	1.246	28.6
40 – zero F	2 gal	10 lb	1.263	30.2

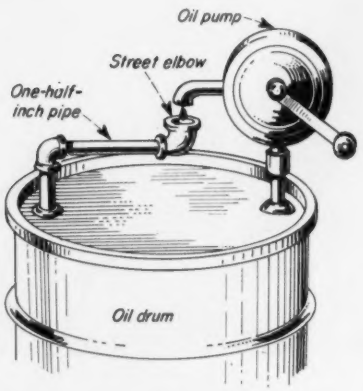
This table is based on granulated 75% calcium chloride

P C ZIEMKE, *Clinton, Tenn.*

Bolt-stretch correction

My article about measuring bolt stretch, POWER, July 57, p 126 should read, "Optimum stretch is *half* the difference between minimum and maximum stretch, added to minimum." That *half* is very important.

H C BOSLEY, *Long Beach, Calif.*



No more oil drips

Easy way to stop messy drips from oil drum pumps is to make drain from standard fittings, sketch. Half-inch fittings turn free in oil drum bent to swing out of way when pump is used. Street elbow acts as funnel and oil dripping from pump runs back into drum without making mess.

C HALLORAN, *Toronto, Can.*

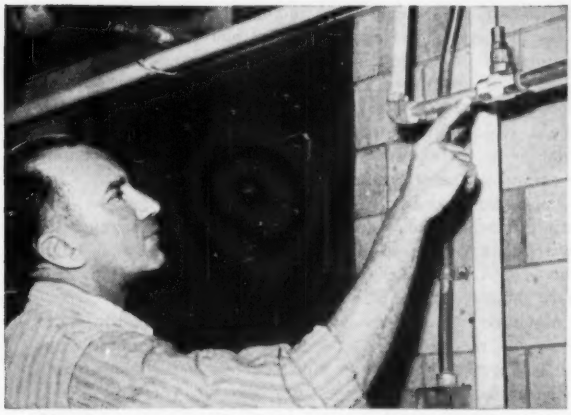
Safety valves

There are three basic type safety valves. Do you know what they are? Do you know how to repair them? *Plant Operators' Manual* shows you with pictures. McGraw-Hill Book Co.

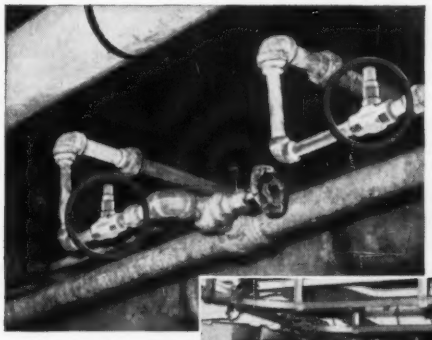
My biggest boner

Please turn to page 226

"these steam traps save us 30,000 gals. of fuel oil a year"



Yarways are responsible for cutting our fuel oil bill 20%



We have Yarways on steam coils for all our smokehouses

Q. Mr. Melcher*, you've been using Yarway Impulse Steam Traps in this packing plant for over two years. What's your experience?

A. It's all been good. As a direct result of changing to Yarway Traps we save 30,000 gallons of fuel oil a year—or about 20% on our oil bill. Temperatures now stay hot and steady.

Q. Where do you have these Yarway Traps installed?

A. On all the steam coils for the smokehouses, heating exhaust fans and hot water generators.

Q. How about maintenance?

A. We haven't touched a Yarway Trap in the two years we've had 'em. With only one small moving part, there's not much to go wrong. Previously, with other traps, we averaged over $300. a year for trap maintenance.

Q. You'd recommend Yarway Impulse Steam Traps, then?

A. I don't have to. The record speaks for itself!

If you'd like a copy of a new booklet, "The How and Why of Steam Trapping", drop a card to

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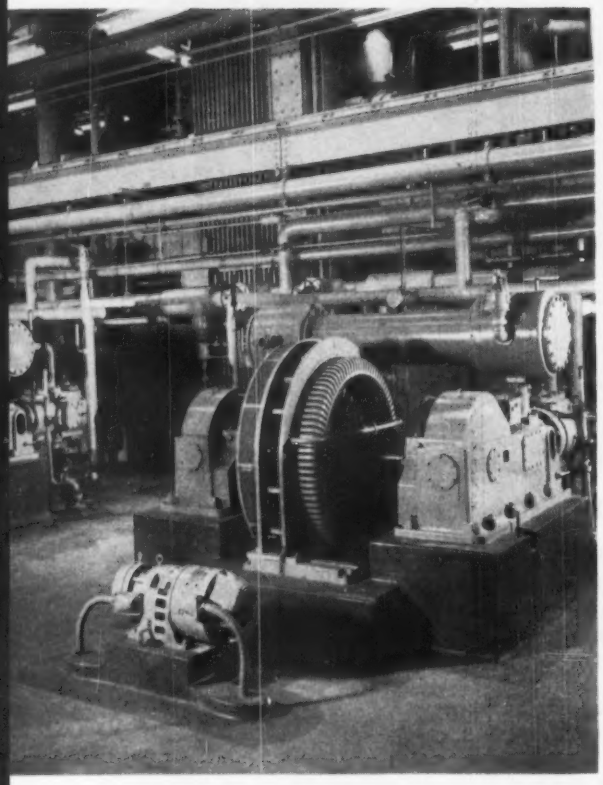


The problem

How can we keep moisture, oil out of our compressed-air lines?

Compressed air is an important power service in our plant. We have three centrally located 125-psi 700-cfm air compressors. They're heavy-duty two-stage double-acting water-cooled vertical-V design. Drives are electric motors. They've given excellent service.

The central compressed-air system is equipped with both intercooling and aftercooling. During some recent maintenance work we've noticed that air being delivered to pneumatic tools has been carrying moisture and oil, adversely affecting tool operation. We're also concerned about the corrosive action on tools and air system. Can readers tell us how to lick this problem?—*CMJ, August Power*

The solutions

Check aftercooler and separator

CMJ should check the aftercooler and separator since they cool the air, separate moisture and oil.

Cooling water should be cold. Good practice calls for cooling air to within 15 F of water temperature. If water is at 95 F, resulting 110-F air would contain 0.36 lb of moisture per 1000 cu ft (based on 125-psig air). 75-F water would yield 90-F air containing 0.21 lb of moisture per 1000 cu ft. Curves are available that show moisture content at various temperatures and pressures.

Separator's ability to eliminate moisture and oil determines overall efficiency of the aftercooler. Checking the separator gage glass tells whether or not moisture is being removed. Condensate should be carried away by an automatic moisture trap.

Moisture legs in the distribution lines collect the water before it reaches tools. Receivers at points remote from the compressor also aid in moisture removal. Receiver and moisture legs require proper drainage, by traps in heated locations or by manual valves in unheated areas.

W H VEDDER, *Buffalo, N. Y.*

Here's 4-step check list

Assuming that all equipment has been properly selected and sized, I would suggest the following steps to solve *CMJ's* problem:

(1) Check heat exchangers. Are the tubes scale free and clean? Clean heat exchanger surfaces are essential to good operation.

(2) Check drain traps on the separators. They may be blocked. Effluent from the separators is an oily sludge that can clog traps. It pays to check drain traps daily.

(3) Check water flow through inter- and aftercoolers. Is the supply adequate? Allow only a minimum temperature rise across the heat exchangers, but don't let water velocity exceed 6 to 8 ft per sec. Tubes tend to erode at higher velocities.

(4) Check lubricators for right operation. Reduce oil feed to compressor cylinders to a minimum. (Check instruction book for exact amount.) Excess oil carbonizes on the cylinders and valves, carries over into the distribution system. Lubricator should be checked daily with stop watch.

H D GORHAM, *Austin, Texas*

Be sure to drain air receiver

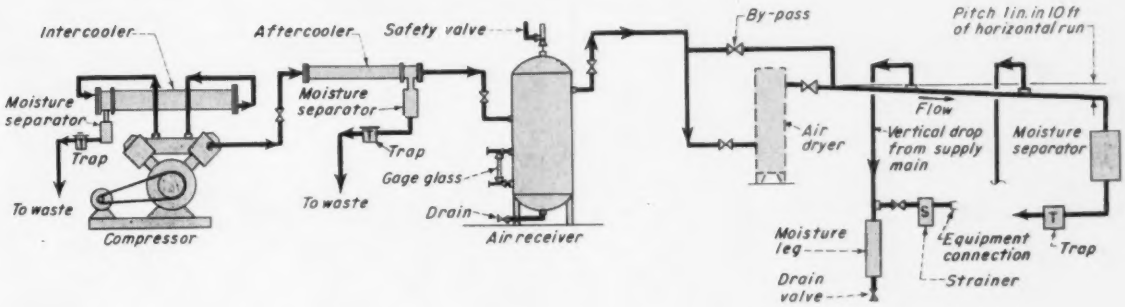
Draining the air receiver is a big help. I was in charge of an air-compressor installation equipped with aftercoolers. The air receiver had to be drained periodically.

An oil separator should be installed after the cooler, and the aftercooler should be checked frequently to make sure that water *is* cool. This should help solve *CMJ's* problem.

J M CURRAN, *Lake St John, Canada*

know-how of over 45,000 Power readers

HOWARD KALLEN, *Associate Editor*



Compressed-air system should be hooked up like this

First, *CMJ* should check the location of air intakes to his compressors. They should be taking air from outside of his plant. If they are above the roof they shouldn't be near any vents that discharge steam.

He should check his inter- and aftercoolers to make sure that tubes are not fouled by an oil film or corrosion on the waterside. Cooling-water temperatures supplying the inter- and aftercoolers should be maintained at right differential in relation to compressed-air temperature. Air must be cooled below its dew point at the corresponding pressure before excess moisture will drop out. Each cooler is equipped with a moisture separator and trap that will discharge the water collected.

Compressed-air line from the aftercooler should enter an air receiver or receivers. With three compressors, air from the aftercoolers can be manifolded and tied into three air receivers. Each receiver outlet is also manifolded to a common supply header. Drain valve, at the low point of the air receiver, permits the operator to drain it once a shift. An automatic drain valve can be installed by connecting controls to the compressor unloading line. Automatic design avoids the neglect that often faces manual valves.

Header from the receivers may be run through an air dryer if *CMJ* can tolerate the additional pressure drop.

Header from the receiver should come off the top third of the tank (for vertical receiver) and should be pitched down from the horizontal, at least 1-in. in 10 ft. Moisture separator and trap at lower end of the header remove moisture.

All connections to tools and equipment come off the top of the supply header and all vertical drops are provided with a moisture leg and drain valve. The moisture leg is at least two pipe sizes larger than the drop line, and about 18-in. long. Drain valve is opened to bleed moisture before connecting any pneumatic tools to the line.

S R Higgins, *Long Beach, Calif.*

What to do about oil, condensate in compressed air

Oil in a compressed-air system comes from three sources:

(1) From the force-feed cylinder lubricator (metering type). Many operators have a tendency to be too liberal with lube oil to the cylinders. Sometimes they use the wrong oil. Flow rate of the right oil to a 9-in. cyclinder should be about two drops per min; to a 15-in. cylinder about four drops per min; to a 20-in. cylinder about five drops per min.

(2) Another source of excess oil, often unrecognized, is the carryover into the cylinder by the oil-wetted piston rod as it overtravels into air cylinder through the stuffing box. Excess oil on the rod is drawn in through the stuffing box on the suction stroke when piston-rod stuffing box is under vacuum.

(3) Oil-impregnated or oil-bath air filters are another source of oil carryover. Impingement-type intake filters may be improperly drained after servicing. Oil-bath types may have wrong oil level, resulting in poor separation of oil from air. Dry-type filters may be a practical solution under certain conditions.

Condensate in compressed air comes from two sources:

(1) As humidity in intake air. Air-intake filters should be located away from steam-exhaust vents or outlets from process.

(2) A small leak in a gasket or packing in the cylinder or aftercooler permits a small amount of water to leak into the air stream. These leaks must be found and eliminated.

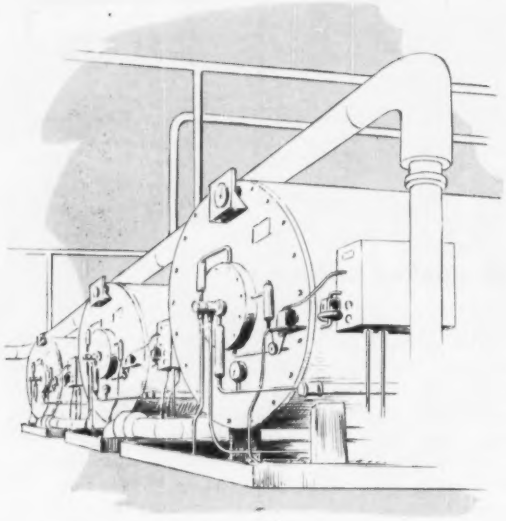
Desiccant filters are available for moisture removal as well as oil removal. Such an absorption-type pipeline filter is particularly effective for air-consuming devices where all traces of water, oil and foreign material must be removed.

J W Reynolds, *Boston, Mass.*

Turn page for info on boiler vibrations ▶

More PLANT PROBLEMS

Begins on page 158



The problem

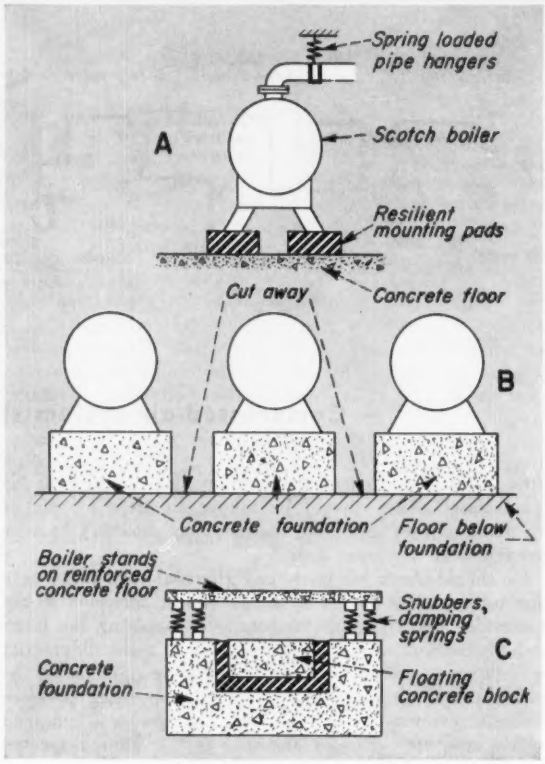
Can vibrations caused by firing be reduced or eliminated?

We have several low-pressure Scotch boilers fired with horizontal rotary burners using No. 6 oil.

At low firing rates we get a mild combustion rumble. When the firing rate is increased, resonance is increased to such an extent that sympathetic vibrations are set up in the building. Noise in the boiler room is so severe that cracks develop in the flue covering and general deterioration sets in throughout the plant. It just isn't good operation.

What can be done to stop the resonance? If readers have had similar problems I'd appreciate hearing of their experiences.—*ABW, August Power*

The solutions



3 ways to eliminate boiler vibration

Assuming that: (1) the rotary burners were checked for dynamic balance (2) air-fuel ratio is OK (3) furnace design is right and (4) smokestack and breeching were properly engineered, *ABW's* trouble is probably due to boilers set on a solid reinforced concrete foundation—no thought being given to vibration damping.

Drawings, above, show three possible ways to correct the situation. Method *A* is least expensive. Method *C* is probably most costly. Method *A* uses resilient pads or damping springs under the boilers' mounting legs.

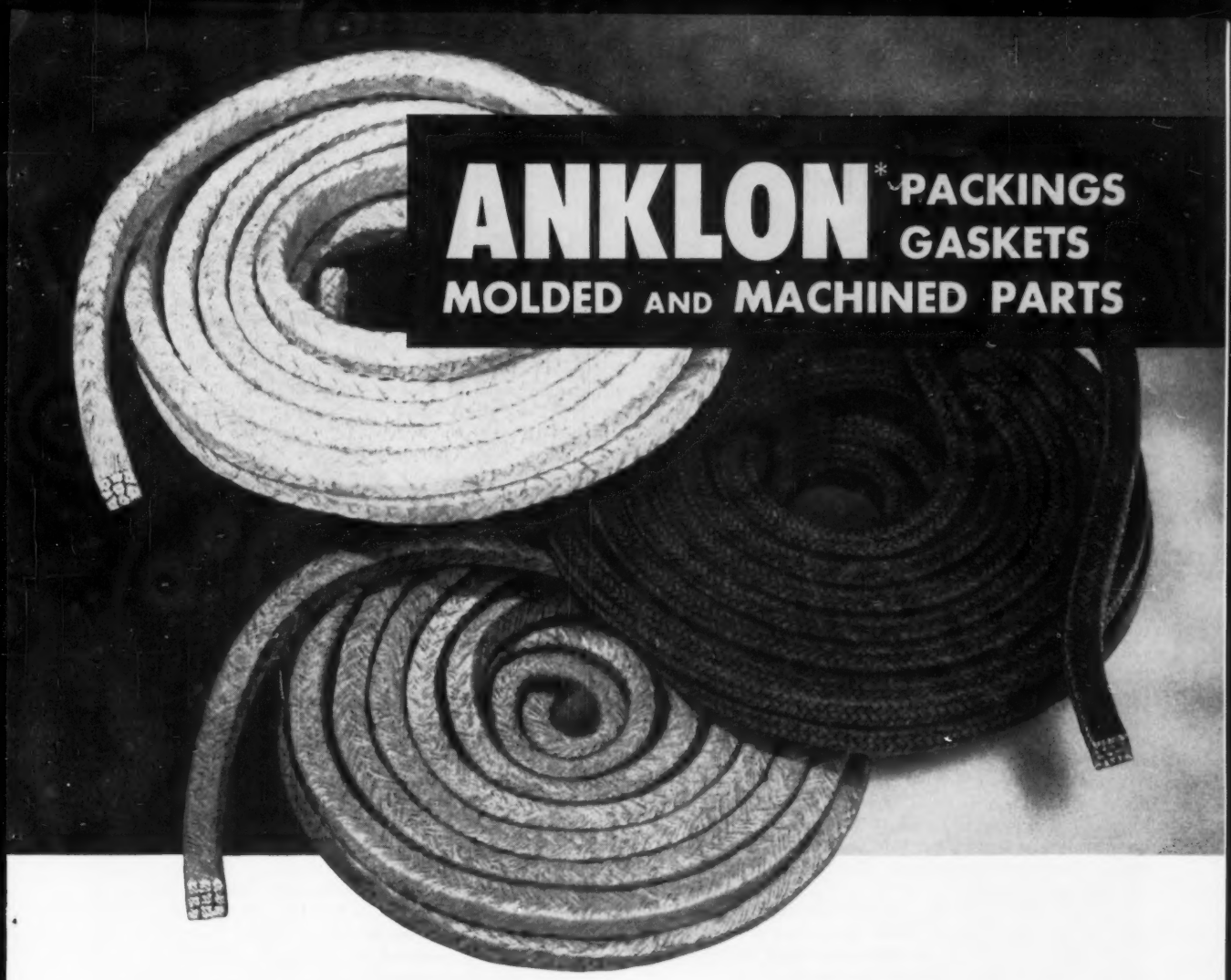
Drawing *B* shows how to isolate each boiler foundation. *ABW* can use pneumatic chisels to cut a dividing lane around each boiler.

Sketch *C* illustrates a foundation design that will support up to 35,000 lb. It consists of a combination of coil-spring mountings and snubbers on a concrete foundation.

L E Polikoff, *Bethpage, N. Y.*

Want help with your plant problems? Send your design and operating headaches to us. We'll put Power readers to work on them

For more on boiler vibrations and new problems, turn page ▶



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More PLANT PROBLEMS Begins on page 158

We had a similar experience

We ran into a similar situation with two packaged boilers equipped with forced-draft burners firing light oil. We finally decided that our problem was of an acoustical nature. By trial and error we fashioned a quarter-wave suppressor which we cut into the stack just above the boiler-flue outlet. Location and diameter of the suppressor tube are not critical. I would suggest that *ABW* start with a tube of about one-third the size of his stack diameter.

Cut a hole into the stack about one ft above the boiler outlet. A tube, about 6-ft long, is attached at right angles to the stack. Then insert a lightweight piston and rod (made of sheet metal and a broomstick or pipe) in the tube. With the burner firing at a point where definite pulsations can be felt, adjust the piston inside the tube to find the tube length that gives the greatest suppressing effect. Cut the tube to this length and cap it.

If *ABW's* burner uses slow-moving natural-draft air, he may have to use a longer tube because of greater wave-length of lower-frequency pulsation.

Some operating men have suggested changing height of the stack to eliminate coincidence with the pulsating wave length, but we have no data to support this theory. We have found that cutting the hole in the stack, as described above, gives good suppression. But this is practical only with forced-draft units.

If *ABW* ever leaves his present position, he should be sure to tell his successor about the suppressor. It looks rather mysterious to see an empty blind-end stub sticking out the stack, unless you know the reason for it.

W McCumber, *Los Angeles, Calif.*

ABW should change burners

ABW should switch to mechanical-type long-flame burners to eliminate his vibration problem. His present burners give a short mushroom flame. Hot combustion gases cool down rapidly when passing the relatively cool furnace flue. Gases are cooled even further in passing back through the boiler tubes, smoke box, breeching and stack.

Resulting low exit gas temperature gives very little pull or draft. Thus a pulsating gas flow is set up, causing severe vibrations.

I know of one plant equipped with two 250-hp cross-drum boilers having two wing burners and one center burner of the pressure-atomizing type, firing No. 6 oil and having a manually controlled steam-engine driven f-d fan. The fireman had to adjust fan speed as load varied, in order to avoid severe vibration.

ABW will find that long-flame burners give greater heat throughout the entire furnace. This will raise his breeching and stack-gas temperatures, resulting in better gas flow. As gas flow becomes more stable, gas vibrations will disappear.

Eliminating air leaks, applying adequate insulation to breeching and (if stack is steel or wrought iron) insulating part of the stack will help to avoid low gas temperatures.

A Belton, *Montreal, Canada*

Are boilers being overloaded?

I'd say *ABW* is trying to overload his boilers. Either the stack is too small or he has insufficient draft for the fuel supply to the burners.

Excessive pulsation is generally the result of too little oxygen and/or poor mixing of air and fuel. Installation of mechanical-draft fans and correctly designed air-inlet devices to promote good mixing of fuel and air should reduce pulsation, improve boiler operation.

C G Hansen, *Sausalito, Calif.*

——Your December problems——

What's a good program for maintaining steam traps?

I've recently taken over responsibility for steam and water services in a medium-sized chemical plant. Judging from past maintenance records, we need to organize our steam-trap maintenance and testing on a regular basis. Also, our maintenance men have no definite established system for performing tests.

Our top steam pressure is 200 psi. We also have 50 psi steam for process heating and 5 psi for space heating. Uncontaminated condensate is returned to a tank at the steam plant.

I would like suggestions on frequency of testing, testing and checking procedures and how to put the maintenance on a program basis.—*EEG*

Why does refrigeration compressor run continuously without reducing chilled-water temperature?

I'm building engineer for a commercial structure that is equipped with two 150-ton centrifugal refrigeration compressors for its air-conditioning system. Chilled water is supposed to leave the evaporator at 50 F (a 10-F temperature drop). Leaving-condenser-water temperature is 95 F (a 10-F temperature rise). Evaporator passes 320 gpm; condenser passes 402 gpm. Motor is 120-hp, 208-v, 3-phase. We've had these machines for seven years, and until recently they've worked fine. Lately, however, the machines have been running almost continuously without depressing chilled-water temperature the required amount. I would like to know the best approach to this problem.—*RSM*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

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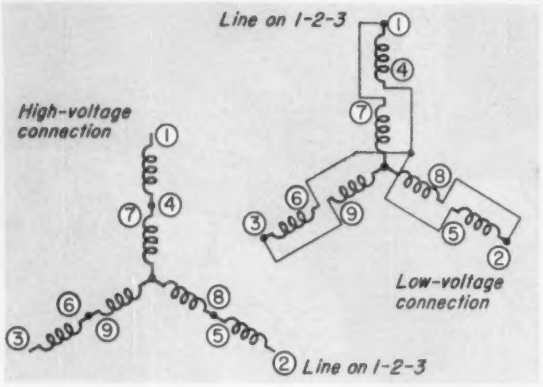
BOB BELLAS, *Assistant Editor*



More about dual-voltage 3-phase motors

I really enjoyed reading "How to connect dual-voltage 3-phase motors" (*Plant Electrical Fact File*, POWER, Oct 1957). Much as I dislike cutting pages from my copies of POWER, I clipped this article for my "ready" reference file.

It can be a tough job to hook up a 9-lead motor after some clown has disconnected it without bothering to mark which lead goes where. Your article may not change the clowns, but it'll brighten the lives of the *electricians* who have to follow them.

With the thought in mind that it's nice to know more than one way to skin a cat, I'd like to outline another method of determining circuits when faced with this hookup dilemma. Basically, it's similar to your article, but it does away with the battery and switch—and the voltmeter, if you substitute a couple of low-wattage lamps in series.

First, if a circuit continuity test gives us three circuits with two leads and one circuit with three leads, we know we're dealing with a wye-connected winding. Next step is to permanently tag the 3-lead circuit, in any order. Remaining six leads should be temporarily tagged 1 and 4 for the first circuit, 2 and 5 for the second, and 3 and 6 for the third. Obviously, all leads should be free and clear and caution exercised during the test procedure.

Attach a 3-phase 220-v line to leads 7, 8 and 9 and the motor will run. If the motor isn't designed for across-the-line start, you'll have to use a reduced-voltage starter as in regular operation. At this point, voltage across each of the three temporarily tagged circuits should be about 125 v.

With the motor running, connect 7 to 4 and measure voltage across 1 and 8 and across 1 and 9. If both are equal (around 335 v), leads 1 and 4 should be permanently marked. If the voltages are equal, but are around 125 v, interchange 1 and 4.

If voltages between 1 and 8 and 1 and 9 are unequal, disconnect 4 from 7 and connect 4 to 8, measuring voltages between 1 and 7 and 1 and 9. Such changes and voltage checks with these leads should continue until both voltages are equal at about 335 v. The leads can then be permanently marked.

Follow the same procedure for the remaining two circuits and permanently mark those leads when their proper position is found. Then, with the leads located and properly tagged, with motor running and 7, 8 and 9 as terminals, connect 4, 5 and 6 together. Voltages between 1, 2 and 3 should be equal at approximately 220 v.

To double-check, stop motor and observe direction of rotation. Now, using 1, 2 and 3 as terminals, and being careful to connect the proper phases formerly led to 7, 8 and 9 (change lines from 7 to 1, 8 to 2 and 9 to 3), connect the external wye 4, 5 and 6 together and leave 7, 8 and 9 open and free.

The motor is ready to run on the other half-winding. However, direction of rotation *must* be the same as when the first half-winding was used with 7, 8 and 9 used as terminals. When this double-check proves we're right, we're all set to completely connect the motor as follows: put leads 4, 5 and 6 together (external wye), 1 and 7 to first phase, 2 and 8 to second phase and 3 and 9 to third phase.

This connects the motor in parallel wye and it should develop full hp and torque in the lower design voltage range. Changing the leads thus: 4 to 7, 5 to 8 and 6 to 9, and using 1, 2 and 3 as motor terminals, puts the motor in series wye which'll let it operate in the higher design voltage range.

CARL BACHMANN, *Jamaica, N. Y.*

EDITOR'S NOTE: *Norm Peach, author of "Electrical Fact File," ran a practiced eye over the above and opines that Reader Bachmann's method is a neat twist for electricians who don't happen to have a battery and switch handy.*

Norm visualizes one possible drawback, however, in Carl's procedure of running the motor first on one-half the winding and then on the other half. This might be tough to do if the job involved a large motor whose windings weren't designed for the stunt.

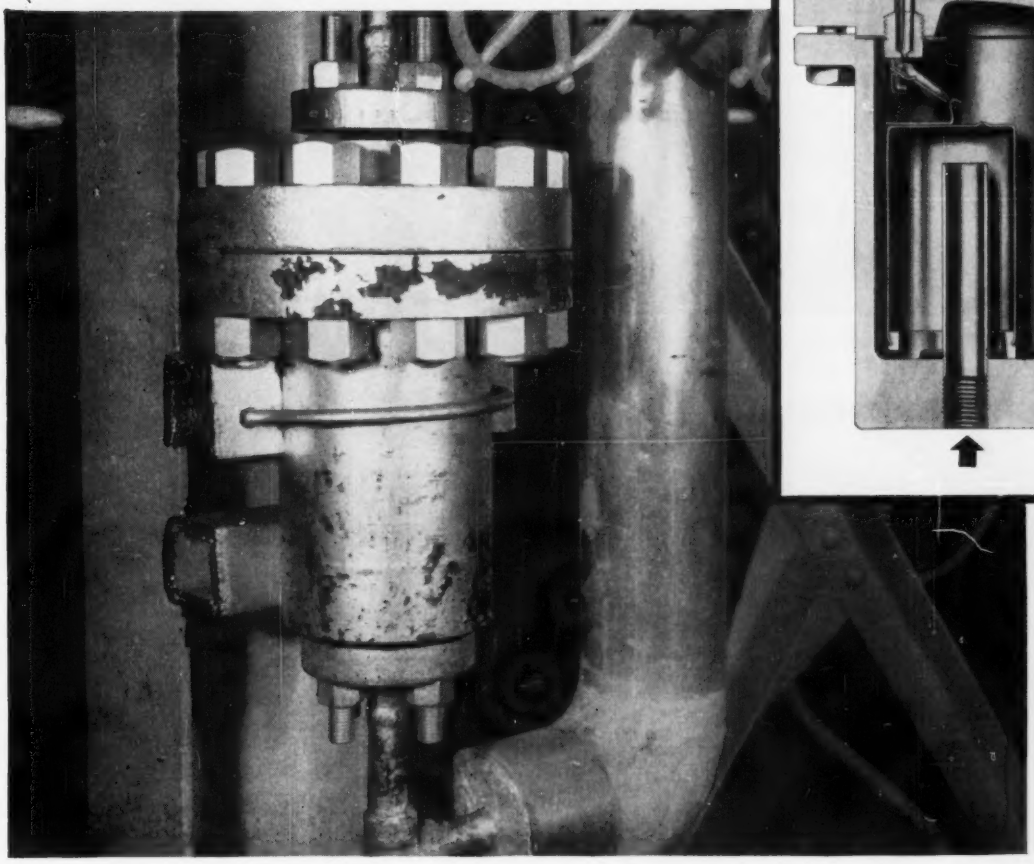
We know we've got some electrical sharpies among POWER *readers. How do you feel about this? Or maybe you've got some other ideas on the whole deal that you'd like to expound? Let's hear from you.*

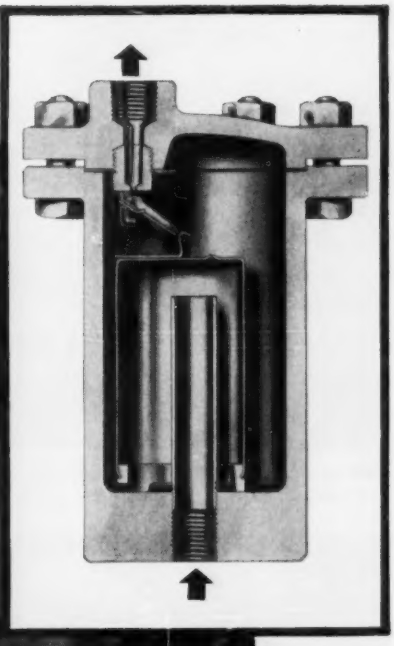
Some guys have an alibi for everything

For years Mike, the 8 to 4 fireman, had reported for work right on the dot. Guys in the plant swore you could set your watch by him. One morning 8 o'clock came and went, but no Mike. 8:30 went by, 9 o'clock came; still no Mike. Finally he came in at 9:10 limping badly and with his arm in a cast. In the chief's office, he explained that he'd gotten dizzy while shaving, fallen three stories from the bathroom window. Broke six ribs and his arm in two places.

When he'd finished, the chief looked at him coldly and said, "That took a whole hour?"

ARMSTRONG FORGED STEEL STEAM TRAPS . . .





. . . the Best Answer to Superheated Steam Line Drainage, because:

LIST OF MATERIALS
ARMSTRONG FORGED STEEL TRAPS

Part	Material
CAP AND BODY FORGINGS	
Up to 600 psi, 750°	1030 carbon steel
Up to 900 psi, 900°	ASTM Spec. F-1 carbon moly steel
Up to 2500 psi, above 900°	ASTM Spec. F-5 chrome moly steel
VALVE AND SEAT	Type 440 chrome steel, heat treated, standard. Stellite available.
LEVER MECHANISM	Stainless steel
BUCKET	Stainless steel
BOLTS	Class C high tensile, high temperature bolting material—125,000 min. tensile.
NUTS	Hex, semi-finish, heat treated for high pressure, high temperature service.
GASKET	Compressed graphited asbestos
INLET TUBE	Wrought iron

1. **Proved** in service in leading power plants throughout the world at pressures to 2400 psig.
2. **Experience** of Armstrong in design, manufacture and application dates back to the *beginning* of the trend to higher and higher pressures.
3. **Automatic** safety assured because of high capacity for warm-up loads; traps don't "forget" to drain the lines, and Armstrong traps *always* open for condensate.
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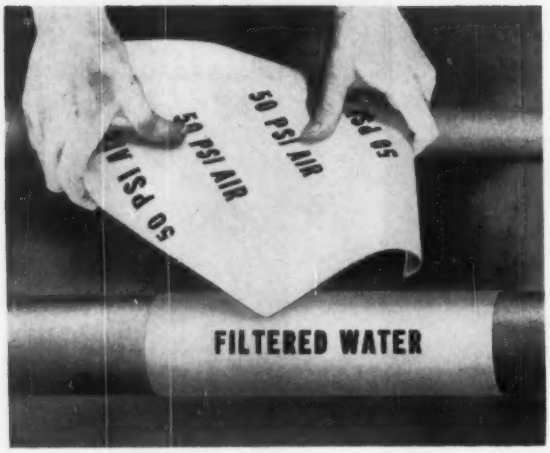
Application Engineered
STEAM TRAPS

SEND FOR THIS LITERATURE:

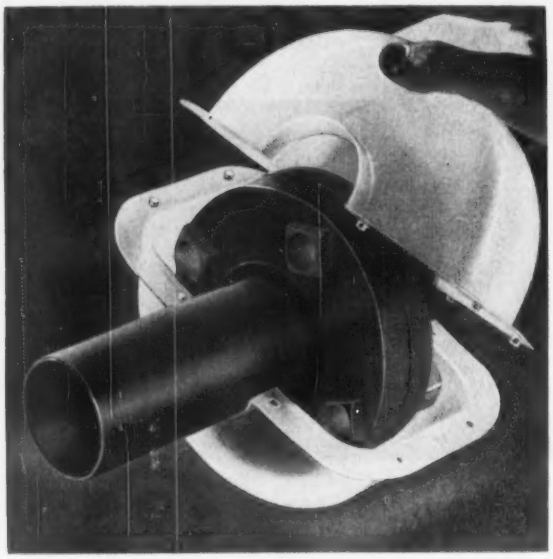
1. Should we trap superheated steam lines? — the answers of 11 engineers who have used traps for this service.

2. Catalog J — complete data on forged steel traps and steam trapping.

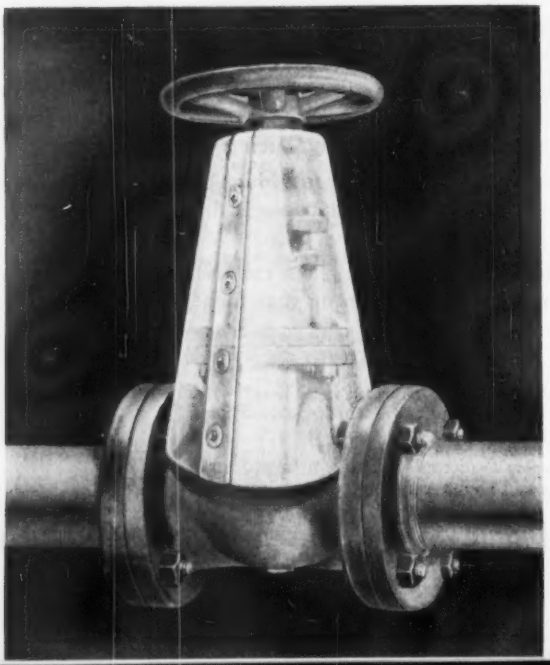
ARMSTRONG MACHINE WORKS, 8123 Maple Street, Three Rivers, Michigan



IDENTIFICATION BANDS tell you content and pressure of line, help prevent costly damage from mistakes. Snap them on



FLANGE SHIELDS prevent chemicals or hot fluids from harming personnel. Can be snapped on quickly, removed in same way



HOW TO

improve your piping

► YOUR PIPING SYSTEMS carry the lifeblood of your busy plant. They deserve all attention possible to keep them working around the clock. Here are three new items you can use to ease your job and protect plant personnel.

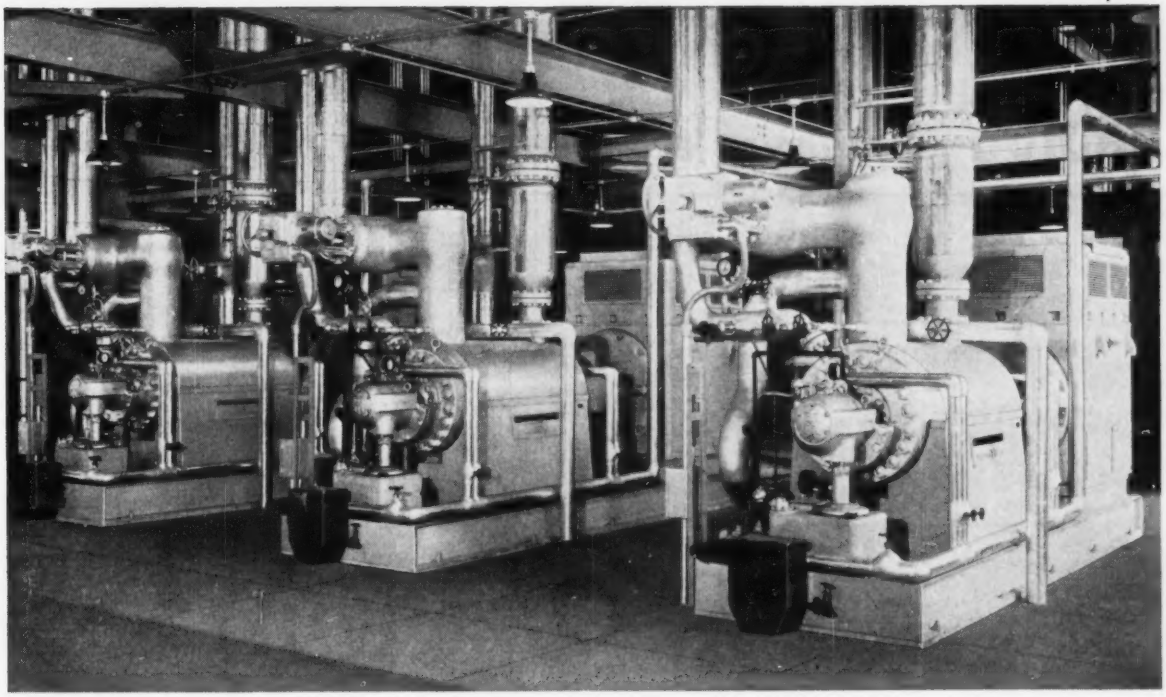
Identification bands. These permanently shaped vinylite plastic labels snap around your piping, prevent serious mistakes. Made in bright, clear colors, they identify your lines and valves, are easy to install. Possible injury to personnel is reduced, as is damage to equipment and process.

Safety flange shields protect personnel from leaking joints. Designed for use on 150- to 300-psi steel-pipe flanges, they can be altered to accommodate nonstandard flanges. Use them on valve flanges, elbows and tees, pump stuffing boxes and packing glands, tank connections. Made of polyethylene, the shields completely cover pipe flange, are unbreakable and can be re-used many times. They can be installed or removed in less than one minute with snap buttons molded as part of the shield; no tools are needed.

Bonnet shields are made in two halves and fastened together with snap buttons. They are semi-transparent, allow you to locate trouble spots without removing them. These shields withstand acids and other corrosive conditions.

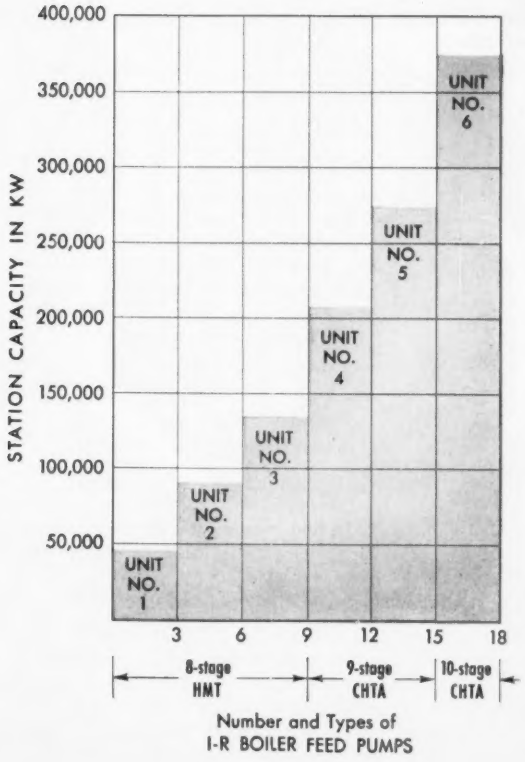
—Courtesy, The Anchor Packing Co, Philadelphia, Pa.

BONNET SHIELDS are transparent, snap in place without removing handwheel or other parts of valve; they're re-usable



3 MORE I-R BOILER-FEED PUMPS

serve Unit No. 6 at H. T. Pritchard Generating Station



THIS latest installation at Indianapolis Power & Light Company's H. T. Pritchard Station brings total plant capacity to 376,000 kw—served by a total of *eighteen* Ingersoll-Rand high-pressure boiler-feed pumps.

Unit No. 6 is served by the three 10-stage Class CHTA boiler-feed pumps shown above, each direct driven by a 1250 hp motor and rated 875 gpm with 4451 ft. total head. These pumps feature Ingersoll-Rand's proven double-case construction and "Unit-Type" rotor assembly. And like all I-R boiler-feed pumps at the H. T. Pritchard Station, they are designed to provide top performance and economy under the most severe operating conditions.

This is another case where I-R boiler-feed pumps have *sold themselves* over and over again, on the basis of past performance in the same power plant. For the best solution to your boiler-feed pump problems, just call your nearest I-R representative.

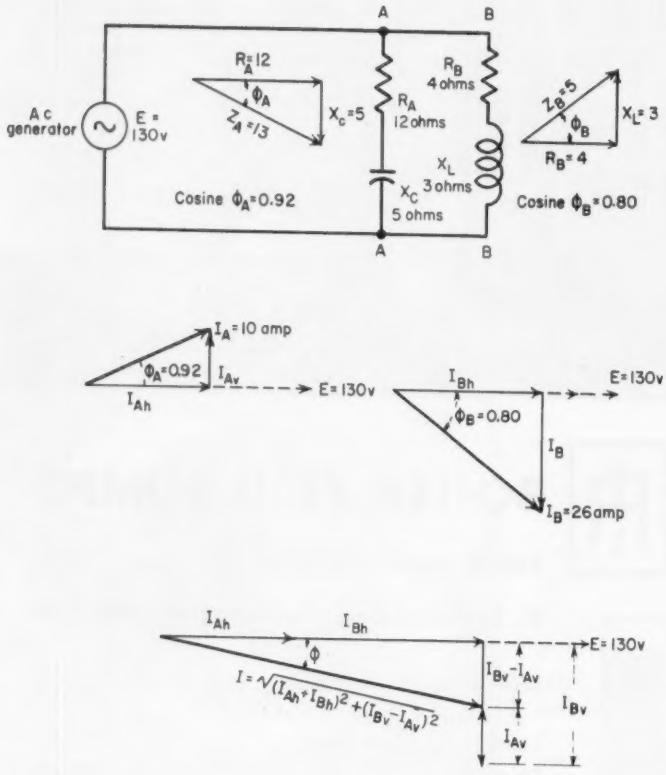
Ingersoll-Rand

10-677 11 Broadway, New York 4, N. Y.

COMPRESSORS • TURBO BLOWERS • CONDENSERS • PUMPS • AIR TOOLS • DIESEL AND GAS ENGINES

BASICS . . . *bringing engineering theory down to earth*

NORMAN PEACH, *Assistant Editor*



Electricity: 16

How to calculate parallel ac circuits

► CIRCUIT CALCULATIONS for ac circuits can be made the same as for dc circuits if all the elements in the circuit are resistors. Power factor of the branches, and of the circuit as a whole, is 1.00. In a similar manner, impedance of parallel circuits that are all inductive or all capacitive can be calculated by treating the reactances of the branches like resistances. Power factor will be zero; that is, current in all-inductive circuits lags the voltage by 90 deg, while current in all-capacitive circuits leads voltage by 90 deg, as explained in *Basics* No. 12 and 13.

Practical circuits rarely have just one kind of circuit element. Series parallel circuits, like the one in sketch, can have resistance, inductance and capacitance. Branch *A-A* has a resistor in series with a capacitor; branch *B-B* has a resistor in series with an inductor. The resultant series impedances, 13 ohms and 5 ohms respectively, are each connected across 130 volts. Using the ac Ohm's law:

$$I_A = \frac{E}{Z_A} = \frac{130}{13} = 10 \text{ amp}$$

$$I_B = \frac{E}{Z_B} = \frac{130}{5} = 26 \text{ amp}$$

These currents are not in phase with the voltage, however. I_A has a phase angle ϕ_A equal to its impedance angle; power factor of branch *A-A* equals cosine of ϕ_A which is R_A/Z_A or 12/13 = 0.92. I_B has phase angle ϕ_B equal to its impedance angle; power factor of branch *B-B* equals cosine of ϕ_B, which is R_B/Z_B or 4/5 = 0.80.

You can find total current by *vector addition* of the branch currents. Break I_A and I_B into horizontal and vertical components as follows:

$I_{Ah} = \cos \phi_A \times I_A = 0.92 \times 10 =$ 9.2 amp

$I_{Av} = \sin \phi_A \times I_A = 5/13 \times 10 =$ 3.8 amp

$I_{Bh} = \cos \phi_B \times I_B = 0.80 \times 26 =$ 20.8 amp

$I_{Bv} = \sin \phi_B \times I_B = 3/5 \times 26 =$ 15.6 amp

(The current values are rounded off at one decimal place for simplicity.)

Add all horizontal (resistive) components of current; find sum of inductive vertical components (if more than one), and sum of capacitive vertical components, and then find the difference. Total current equals:

$$I = \sqrt{(I_{Ah} + I_{Bh})^2 + (I_{Bv} - I_{Av})^2}$$
$$= \sqrt{(9.2 + 20.8)^2 + (15.6 - 3.8)^2}$$
$$= \sqrt{1039} = 32.2 \text{ amp}$$

Power factor equals cosine of ϕ

$$= \frac{I_{Ah} + I_{Bh}}{I} = \frac{30}{32.2} = 0.93$$

To find impedance equivalent to combined impedances, use ac Ohm's law:

$$Z = \frac{E}{I} = \frac{130}{32.2} = 4.0 \text{ ohms}$$

If you want equivalent resistive and reactive components, R_{equiv} = cosine $\phi \times Z = 0.93 \times 4.0 = 3.7$ ohms X_{Lequiv} = sine $\phi \times Z = 0.37 \times 4.0 = 1.5$.

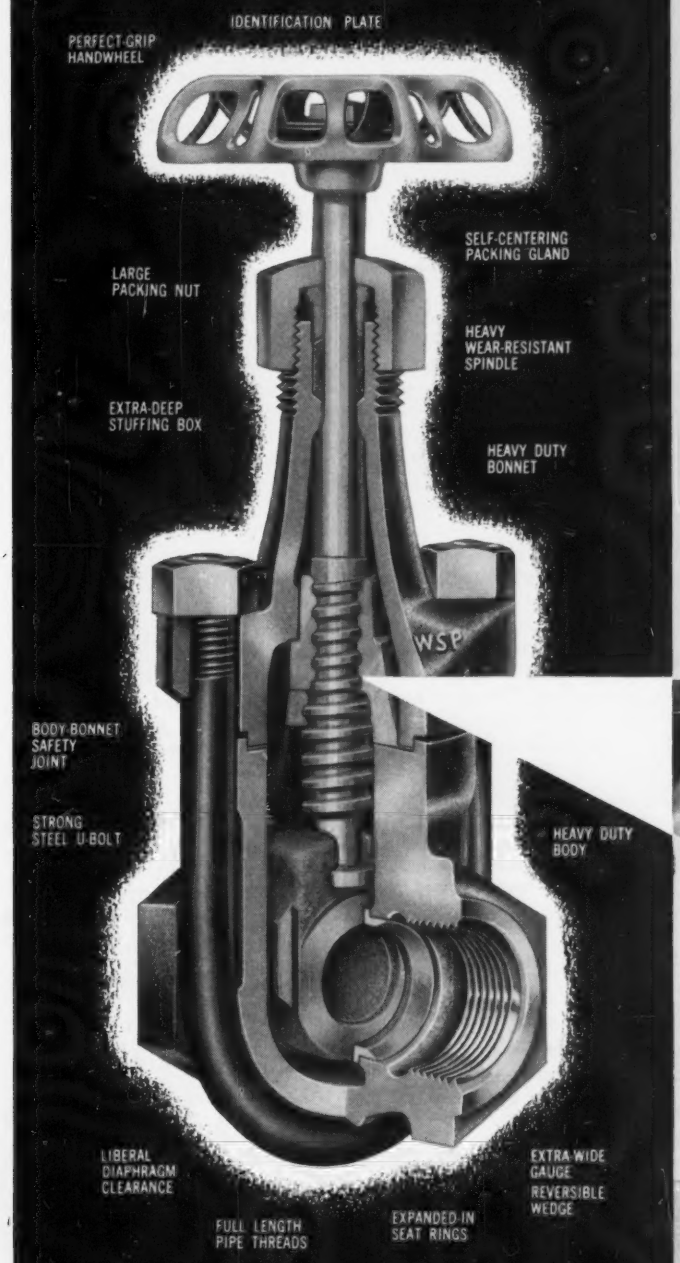
In complicated circuits, or when numerous calculations have to be made, the method of complex algebra is generally used, which we won't take up.

Next month: What a transformer does

Only the big line of

JENKINS U-BOLT GATES

has all these dollar-saving features



WIDE CHOICE

Inside Screw and O.S.&Y., patterns . . . Iron Body with Bronze or Stainless Steel Mounting, All Iron, Ni-Resist with Type 316 Stainless Steel trim. GET FOLDER NO. 207 about the complete line. Ask your local Jenkins Distributor, or write Jenkins Bros., 100 Park Avenue, New York 17.

Priced no higher

DESIGNED TO COST LESS TO USE

Built right into a Jenkins U-Bolt Gate Valve are dollar-saving features no other can match. Construction superiorities that equip this valve to take punishment longer . . . saving dollars in replacement bills. Features that cut maintenance time and the cost of replacement parts . . . saving more dollars. For a good example, look at the unique Renewable Bonnet Saver Bushing which is a patented feature of Inside Screw valves.

BONNET-SAVER BUSHING

No need to junk a bonnet with worn operating threads. Just slip in a new bushing for good-as-new thread engagement . . . saving bonnet and lengthening spindle life.

JENKINS

LOOK FOR THE JENKINS DIAMOND

VALVES

JENKINS SINCE 1864 Jenkins Bros.

Sold Through Leading Distributors Everywhere

Marmy's hot tomatoes

► ONE THING ABOUT OUR POWER staff—we don't fool around when there's a job to do. Take that overstuffed 75th anniversary issue of more than 700 pages, for example. We put that issue to bed with a party at New York's swanky Savoy-Plaza Hotel on Fifth Ave at Central Park.

With all the boys and girls there, including space salesmen from all parts of the country, the party really rolled along. But just as Shelton Fisher announced that Editor Lou Rowley would take over his duties as Publisher on the first of October, all hell broke loose.

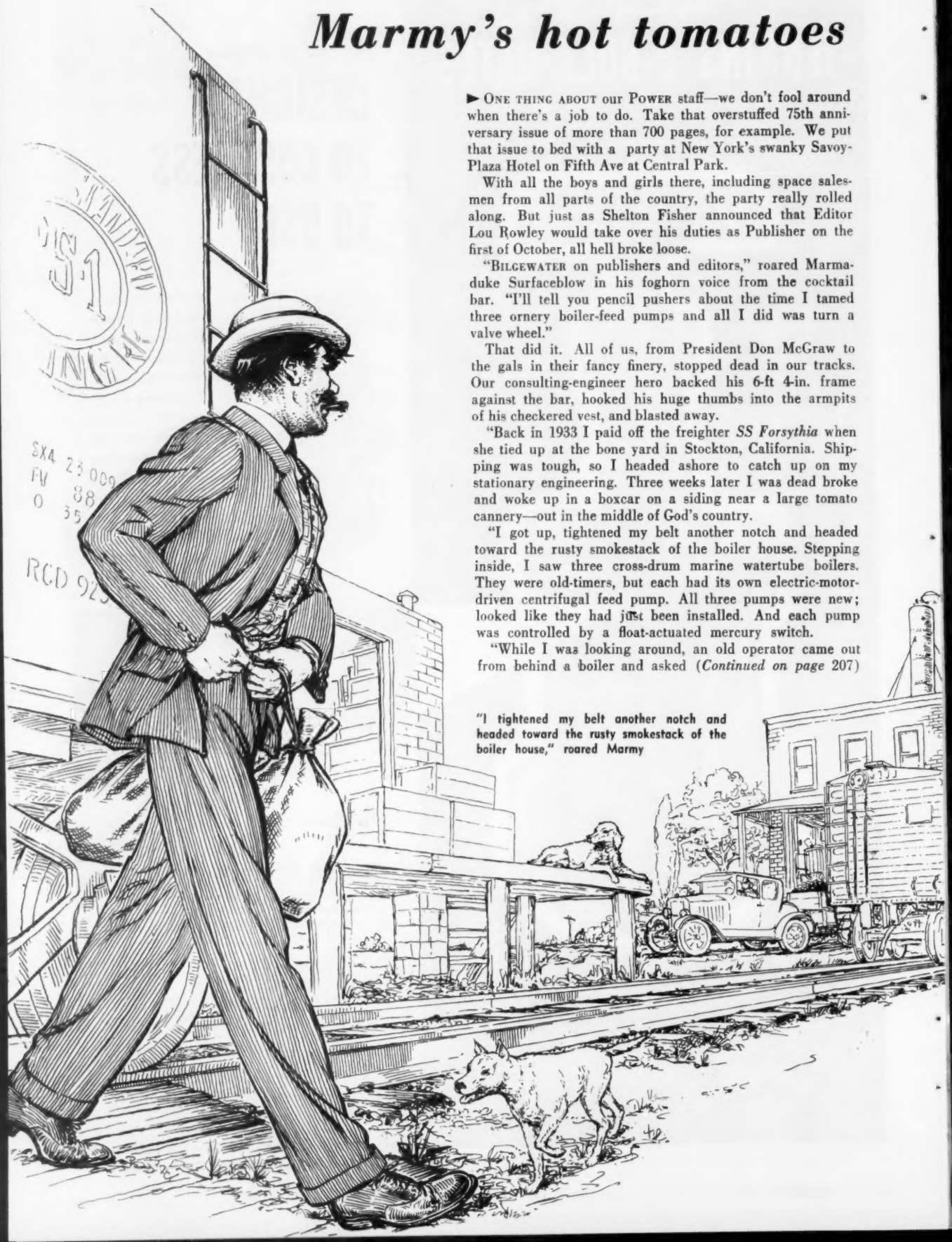
"BILGEWATER on publishers and editors," roared Marmaduke Surfaceblow in his foghorn voice from the cocktail bar. "I'll tell you pencil pushers about the time I tamed three ornery boiler-feed pumps and all I did was turn a valve wheel."

That did it. All of us, from President Don McGraw to the gals in their fancy finery, stopped dead in our tracks. Our consulting-engineer hero backed his 6-ft 4-in. frame against the bar, hooked his huge thumbs into the armpits of his checkered vest, and blasted away.

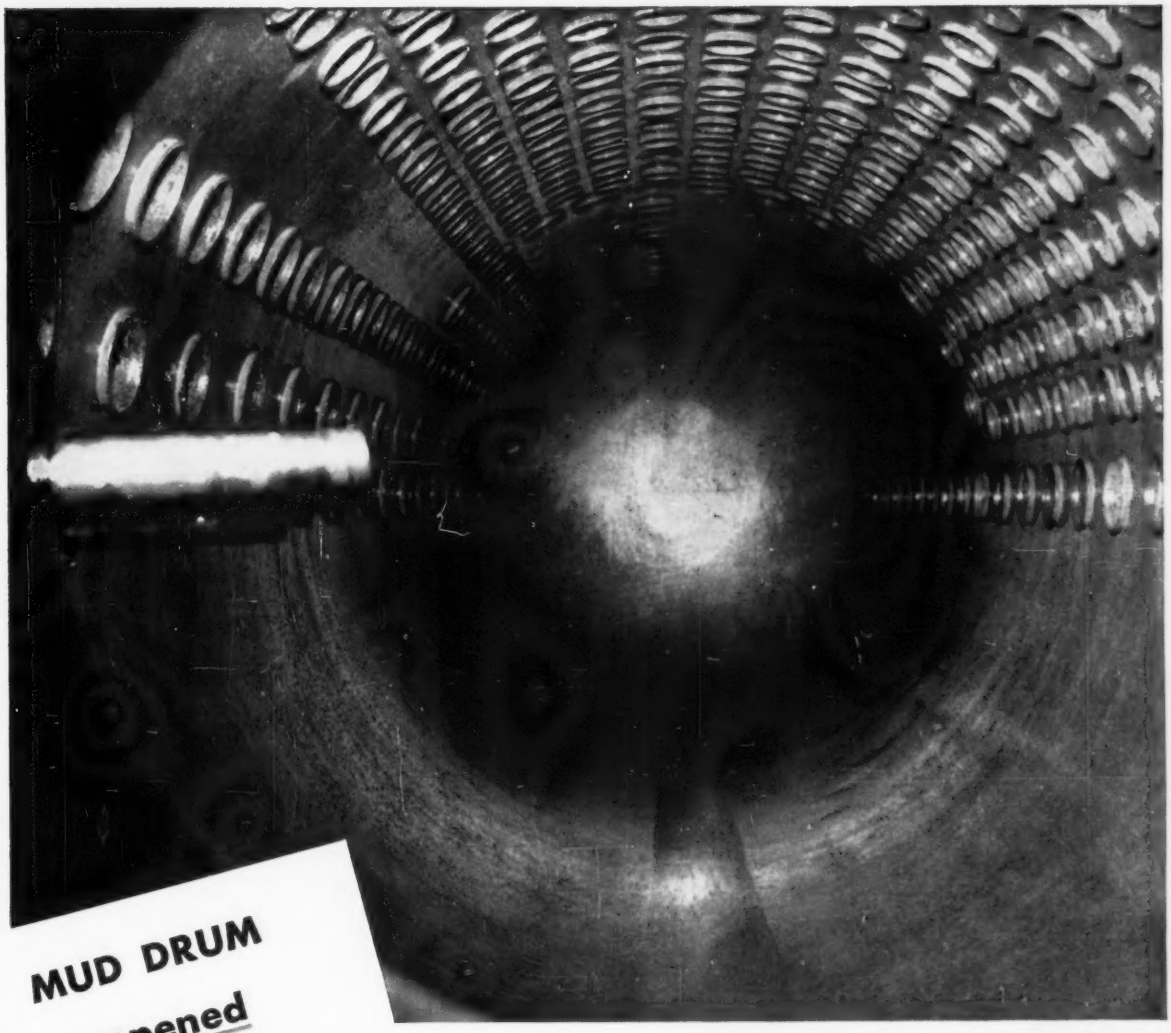
"Back in 1933 I paid off the freighter *SS Forsythia* when she tied up at the bone yard in Stockton, California. Shipping was tough, so I headed ashore to catch up on my stationary engineering. Three weeks later I was dead broke and woke up in a boxcar on a siding near a large tomato cannery—out in the middle of God's country.

"I got up, tightened my belt another notch and headed toward the rusty smokestack of the boiler house. Stepping inside, I saw three cross-drum marine watertube boilers. They were old-timers, but each had its own electric-motor-driven centrifugal feed pump. All three pumps were new; looked like they had just been installed. And each pump was controlled by a float-actuated mercury switch.

"While I was looking around, an old operator came out from behind a boiler and asked (*Continued on page* 207)



"I tightened my belt another notch and headed toward the rusty smokestack of the boiler house," roared Marmy



MUD DRUM
as opened
after one year
on line
with
THE *Nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

● Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

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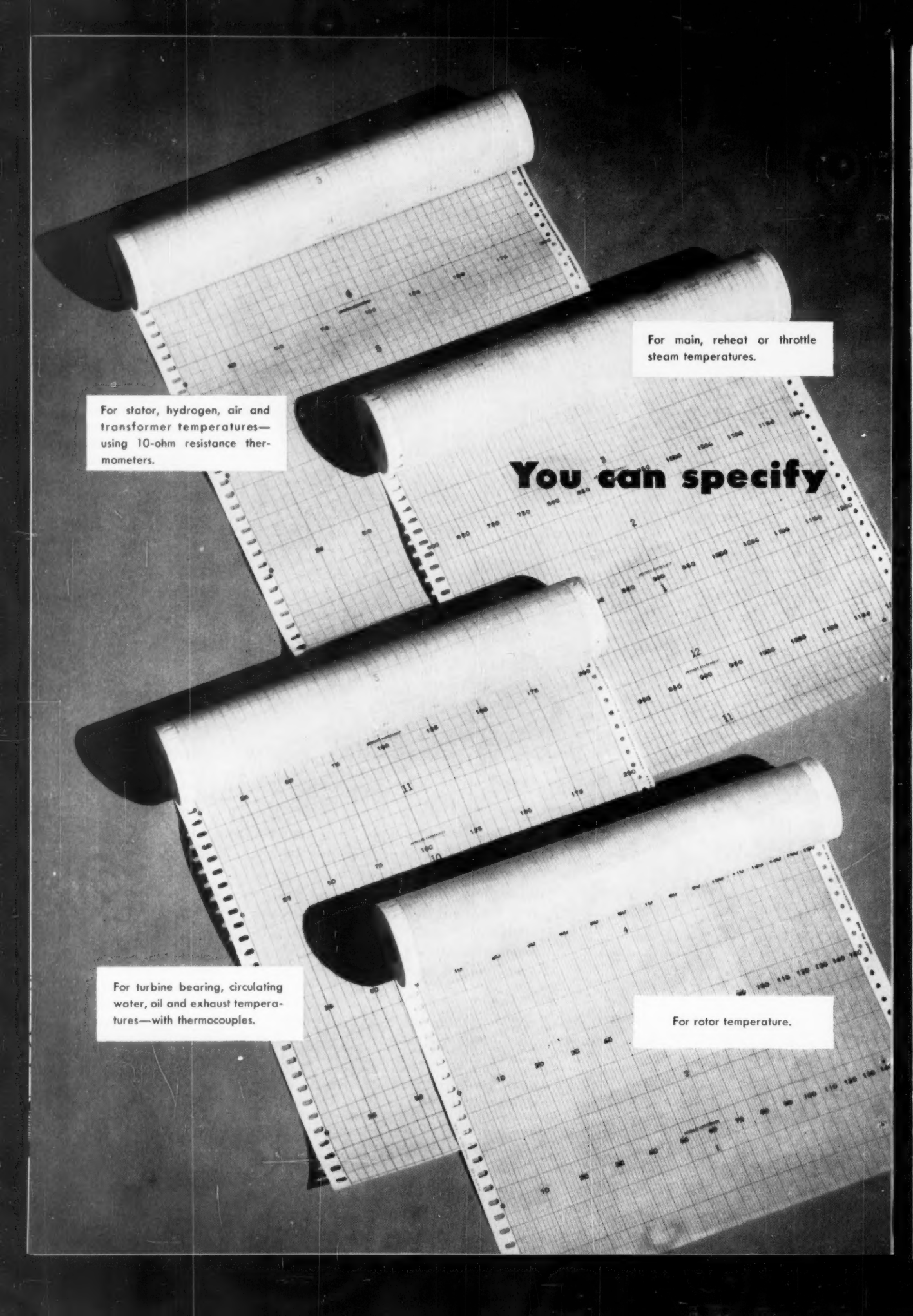
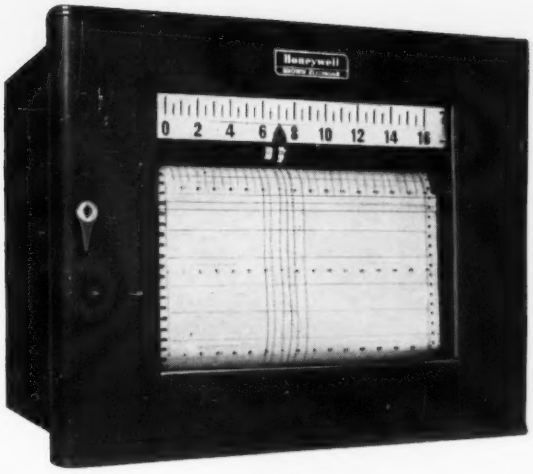
THE *Nalco*® SYSTEM . . . Serving Industry through Practical Applied Science


You can specify
For stator, hydrogen, air and transformer temperatures—using 10-ohm resistance thermometers.
For main, reheat or throttle steam temperatures.
For turbine bearing, circulating water, oil and exhaust temperatures—with thermocouples.
For rotor temperature.



ElectroniK strip chart recorders can be supplied for power plant use with scores of different temperature calibrations. Some of the typical standard charts are shown on the opposite page. Actual chart size is 11 inches in calibrated width.

an *ElectroniK* recorder ... for any of your temperature measurements

LET *ElectroniK* recorders keep constant watch over your plant temperatures—accurately, efficiently.

Choose one *ElectroniK* instrument to record a single temperature, or another to combine as many as twenty temperature records on a single chart. When several temperatures are combined on one chart, correlation is simple . . . operators can keep close check on trends . . . engineers can analyze operation in accurate detail.

Built-in circuits adapt these recorders for signalling excess temperatures. And there's a complete Honeywell line of thermocouples, extension wires, and power-plant-type resistance thermometers to work with *ElectroniK* instruments.

ElectroniK instruments are famous for their stamina and dependability. For a discussion of how they can be applied to measuring your plant temperatures, call your local Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Bulletin 9070, "Instruments for Electrical Power Generation."

Honeywell

First in Controls

Reader service section

Start with these quick samples...

Self control . . .

is the motto of Niagara-Mohawk Power Corp engineers, and they're really doing something about it, with an automatic load-frequency control system directing routing of 2,600,000 kw of electricity. System is one of the most advanced in its field, can detect and interpret changes as small as one part in 4000 to keep the power flowing.

Reports from the field, p 176

Maintenance costs . . .

are always a headache, but closer cost figuring may help reduce the pain. We've abstracted a paper on "Incremental maintenance costs of steam-electric generating stations," plus othe rreports on atomic power power and feedwater treatment. Of course, if the digests intrigue you we've included dope on how to get the complete story.

Technical briefs, p 178

New design . . .

for low-voltage switchgear equipment produces circuit-breaker units that are one-third smaller and 55% lighter, simplify operation and servicing. Other plant equipment features include a retractable-burner nozzle, a high-pressure purifier, a small-sized heat exchanger for liquid samples and a page apiece of meters and valves.

Plant equipment news, p 182

Engineering manual . . .

is offering No. 25 in our December literature columns. "Steam heating coils," "Flexible cushion couplings" and "Basic safety controls for l-p steam boilers" are there othe rtitles from a set of descriptive booklets, pamphlets, catalogs and spec sheets we've assembled for your winter's reading pleasure. For a full listing, turn to . . .

Free literature, p 191

Last but never least . . .

comes George Edwards. Now that the old year is about over, we're all starting to draw up a mental list of good resolutions. One of the best, George thinks, is "let's not waste our time!" If a shortage of days, hours or even minutes worries you, as it certainly does up, why not see what your old friend has to say on the subject.

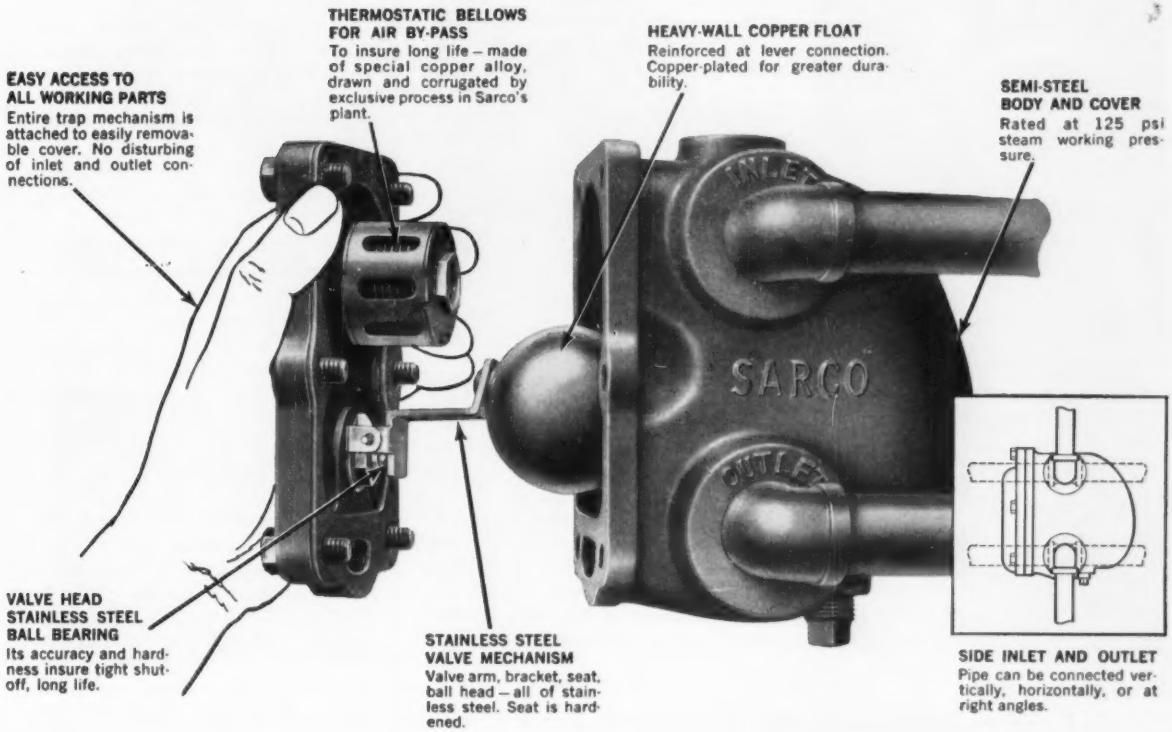
George Edwards, p 194

For other timely ideas, see following service pages ▶

Now...more trapping value for your money!

NEW SARCO FLOAT-THERMOSTATIC STEAM TRAP

with improved engineering features


EASY ACCESS TO ALL WORKING PARTS
Entire trap mechanism is attached to easily removable cover. No disturbing of inlet and outlet connections.
THERMOSTATIC BELLOWS FOR AIR BY-PASS
To insure long life – made of special copper alloy, drawn and corrugated by exclusive process in Sarco's plant.
HEAVY-WALL COPPER FLOAT
Reinforced at lever connection. Copper-plated for greater durability.
SEMI-STEEL BODY AND COVER
Rated at 125 psi steam working pressure.
INLET
SARCO
OUTLET
VALVE HEAD STAINLESS STEEL BALL BEARING
Its accuracy and hardness insure tight shut-off, long life.
STAINLESS STEEL VALVE MECHANISM
Valve arm, bracket, seat, ball head – all of stainless steel. Seat is hardened.
SIDE INLET AND OUTLET
Pipe can be connected vertically, horizontally, or at right angles.

This new, improved Sarco Float-Thermostatic Steam Trap Type FT discharges condensate at steam temperature continuously and without shock.

Recommended to drip steam mains, unit heaters, blast coils, heat exchangers, and other allied process equipment, requiring accurate temperature control.

Air Binding Impossible – equipped with separate thermostatic air vent, which removes automatically and immediately all air and incondensable gases reaching trap. Balanced pressure vent self-adjusts to all operating pressures. Its location above condensate level permits discharge of air and gases reaching trap after start-up. Does not require adjustment when pressures change.

Sizes – ¾ and 1"
For steam pressures – 0 to 125 psi

Write for Bulletin 455-B to Sarco Company Inc., 635 Madison Avenue, New York 22, N.Y.

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SARCO

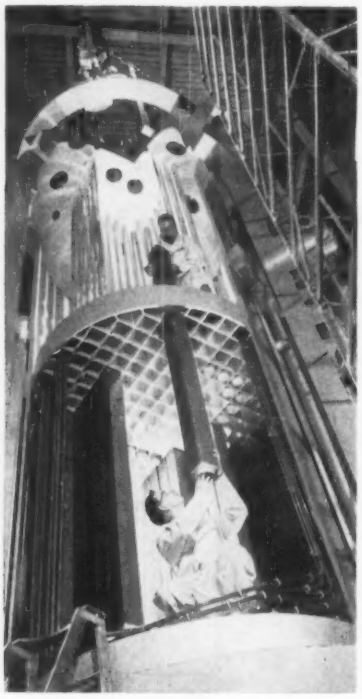
REMEMBER— only Sarco makes all types	Thermostatic Steam Traps	Liquid Expansion Steam Traps	Thermo-Dynamic Steam Traps	Float Thermostatic Steam Traps	Camlift Bucket Steam Traps

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 252

Engineers study full-size reactor model



► WOOD, PLASTIC AND METAL go into the making of an actual-size mock-up of the atomic reactor for the first full-scale nuclear power plant in the U.S. designed to generate electricity. Model is being used for engineering-development work at AEC's Pittsburgh Bettis plant, which is operated by Westinghouse Electric Corp.

Actual reactor will be located at Shippingport, Pa., site of atomic power station now being built as a joint project by AEC and Duquesne Light Co of Pittsburgh. Main purpose of model is to determine shape and placement of pipes and cables to be installed in real reactor. Model is 45-ft high, 10 ft in diameter, and strong enough to carry eight tons of material —a fraction of weight load real reactor frame will handle. One side of mock-up is open to permit engineers to enter and work with various parts.

When plant is completed, reactor inside vessel will act as furnace in which uranium atoms are split to produce heat. Water will be heated, pumped to heat exchanger which will produce steam to drive turbine.

Load control works for Niagara-Mohawk

► NEW LOAD-FREQUENCY control system at the Niagara-Mohawk Power Corp is an outstanding illustration of one basic tenet of today's power-plant thinking: automatic control systems of the right kind do pay off.

Niagara-Mohawk supplies electricity to 1,038,000 customers in a 36-county 22,000-sq mile N. Y. State area extending from the Niagara frontier to the Hudson River valley. About 100,000 miles of transmission, distribution and feeder lines carry a total capacity of 2,600,000 kw. Stations in Buffalo are interconnected with other power systems extending from Boston to Detroit; from Pennsylvania in the south to Canada in the north.

Problem of tie-line bias control at Buffalo is complicated by hydro power from Canada. The new load-control installation, designed by Minneapolis-Honeywell, keeps tabs on interchange of power between Niagara-Mohawk and neighboring utilities. Honeywell system operates to correct system frequency and to assure proper allocation of power generation. (See *Today's Development Report* coming in January POWER for current practices in load-frequency control.)

Nerve center of system is a digital potentiometer, precise enough to detect changes as minute as one part in 4000 in temperature, pressure, kw, flow or vibration. Unit collects data in the form of an unknown voltage, which it measures against a known voltage. It then interprets voltages, transforming them into four digits and printing them on punched tape.

Load-control system has to be flexible to permit load dispatcher to change sched- (*Continued on page* 248)

Power Lines

"Point four" plan on the part of private industry will export U.S. "know-how" to firms down under. Arrangement between Burndy Corp of Norwalk, Conn. and Electrical Equipment of Australia, Pty, sends technical aid to Australia, Australian pounds to U.S. Aussie company will get engineering drawings, access to labs, expert advice.

Joint research project to convert sea water to fresh is scheduled by seven California electric utilities and the Dept of the Interior. Partly spent low-temperature steam from steam-electric stations will be used. Pilot test plant may be set up at Southern Calif. Edison Co's Mandalay Steam Station near Oxnard, Calif.

Bonn, Germany (McGraw - Hill World News)—Steam power plant, said to be biggest in Europe, is under construction in Luebbenau near Berlin, E Germany. Plant will have capacity of 1300 mw; produce 9 billion kwhr of electric current per year according to official announcements. Total cost should be $50 million at western conversion rate.

Air-filled plastic bubbles may be construction material of the future; require nearly constant electrical supply. Plastic or fiber membrane encloses air, electricity supplies necessary pressure differential. "Bubble buildings" would save on building materials, but might gently collapse like a toy balloon if accidentally punctured.

New mathematical technique makes application of electrical laws to mechanical problems in piping systems practical for the first time. Technique, an application of Kirchhoff's laws to more complex structures using tensor method of analysis, measures exact stresses in power-plant piping under high pressures and temperatures.

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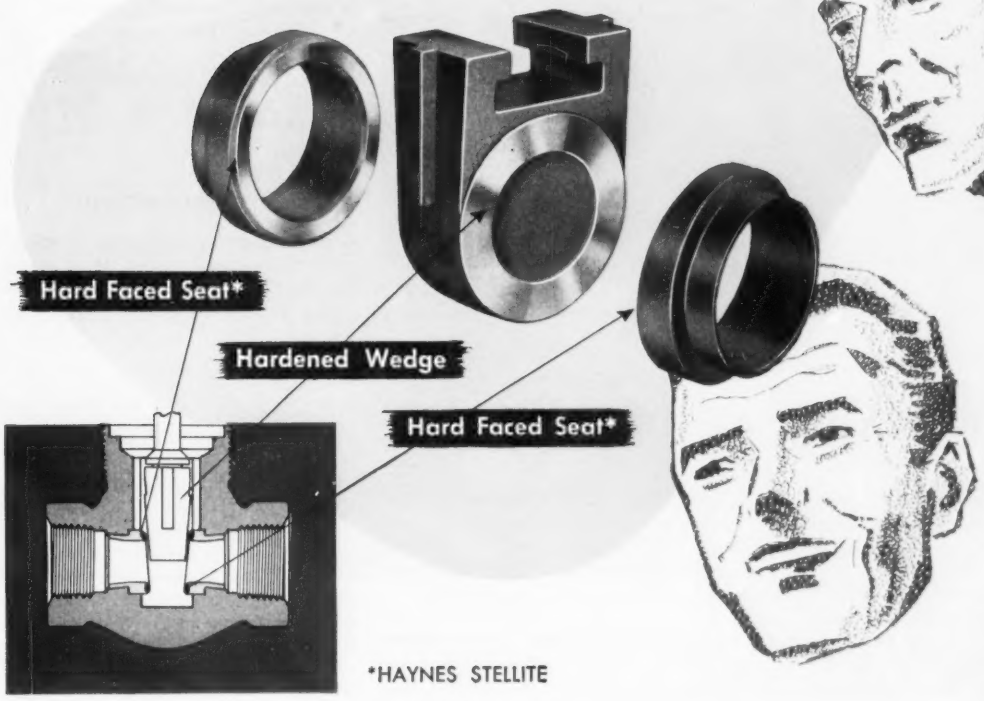
Toughness



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Vogt GP Valves feature the toughest and, since they are precision finished, the smoothest seating surfaces obtainable anywhere. That's why they are setting new standards of performance—longer, drop-tight service with minimum, low cost maintenance—in petroleum refineries, chemical plants, power plants and other industries. Available in a complete range of sizes from 1/4" to 2" and rated 800 pounds at 850° F. and 2000 pounds at 100° F.

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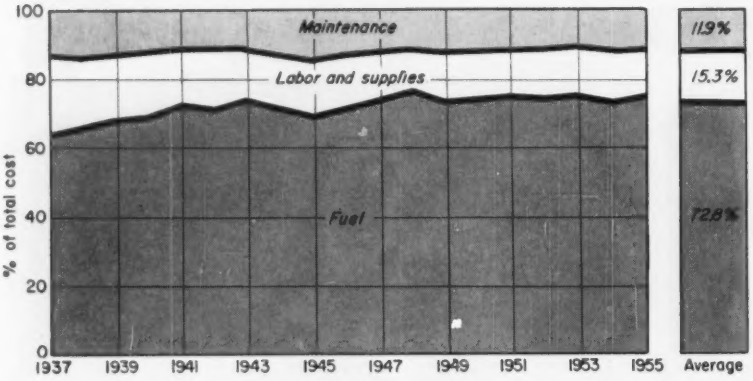


PRODUCTION COSTS for steam plants of Class A and B privately owned utilities

Statistics analyze maintenance costs

Incremental maintenance costs of steam-electric generating stations. *By M J Steinberg, Consolidated Edison Co of New York, Inc.*

One of the major objectives of economic load dispatching is the production of electric energy at the lowest possible cost consistent with the requirements for service reliability.

With respect to fuel burning steam plants, production costs include fuel, maintenance, labor and supplies. Of these fuel and maintenance are affected most by a change in generation.

The distribution of production costs is shown in chart above for the Class A and B privately-owned companies, as reported by the Federal Power Commission for the 19-year period from 1937 to 1955. Fuel, of course, is the major element of production cost.

Although it is possible to establish with acceptable precision the hourly fuel costs expressed as a function of the kw load generated, from which the conventional incremental unit fuel cost data can be derived, no acceptable method has yet been developed for establishing a similar relation for maintenance costs. So it has become almost the universal practice to estimate incremental maintenance costs as a matter of judgment, based to a large extent on prevailing maintenance costs as carried on the books of account. This paper offers some comments on the use of statistical cost data for the purpose of approximating incremental maintenance costs of generating stations. *AIEE paper, No. 57-1060.*

Digital computers for power system problems. *By Computer Application Subcommittee of the Committee on System Engineering of the American Institute of Electrical Engineers.*

Some of the problems to which digital computers might be applied include load forecasting or probability studies to estimate reserve requirements, heat balance calculations, electric circuit problems. Some electrical utility companies are applying automatic digital computers to engineering problems now being done with other tools, for example, in the normally ac network-analyzer applications. Other uses are for determining loss-formula coefficients, swing curve calculations, transient problems.

AIEE has collected eight papers presented at the 1956 Fall General Meeting, dealing with digital computers for power system problems. The titles are: Digital computers can aid utilities; What is a digital computer?; Elementary problem preparation, flow diagrams, etc; Organization and personnel; Principles of programming; Electromechanical accounting machines for power engineering; Use of digital computers in coordination of system generation; Digital calculation of short-circuit currents in large complex-impedance networks. *AIEE publication, No. S-90.*

Directions for ordering papers on page 246

Power generation

Grounding of power station 4160-volt auxiliary systems. *By T H McGreer, Westinghouse Electric Corp.*

As the size of power station units has increased, it has become economical to raise the voltage on auxiliary systems to 4160 volts. Almost universally, 2400 volt systems were operated ungrounded. With the higher voltage, the question again arises whether the system should be grounded, and if so, whether neutral impendance should be provided.

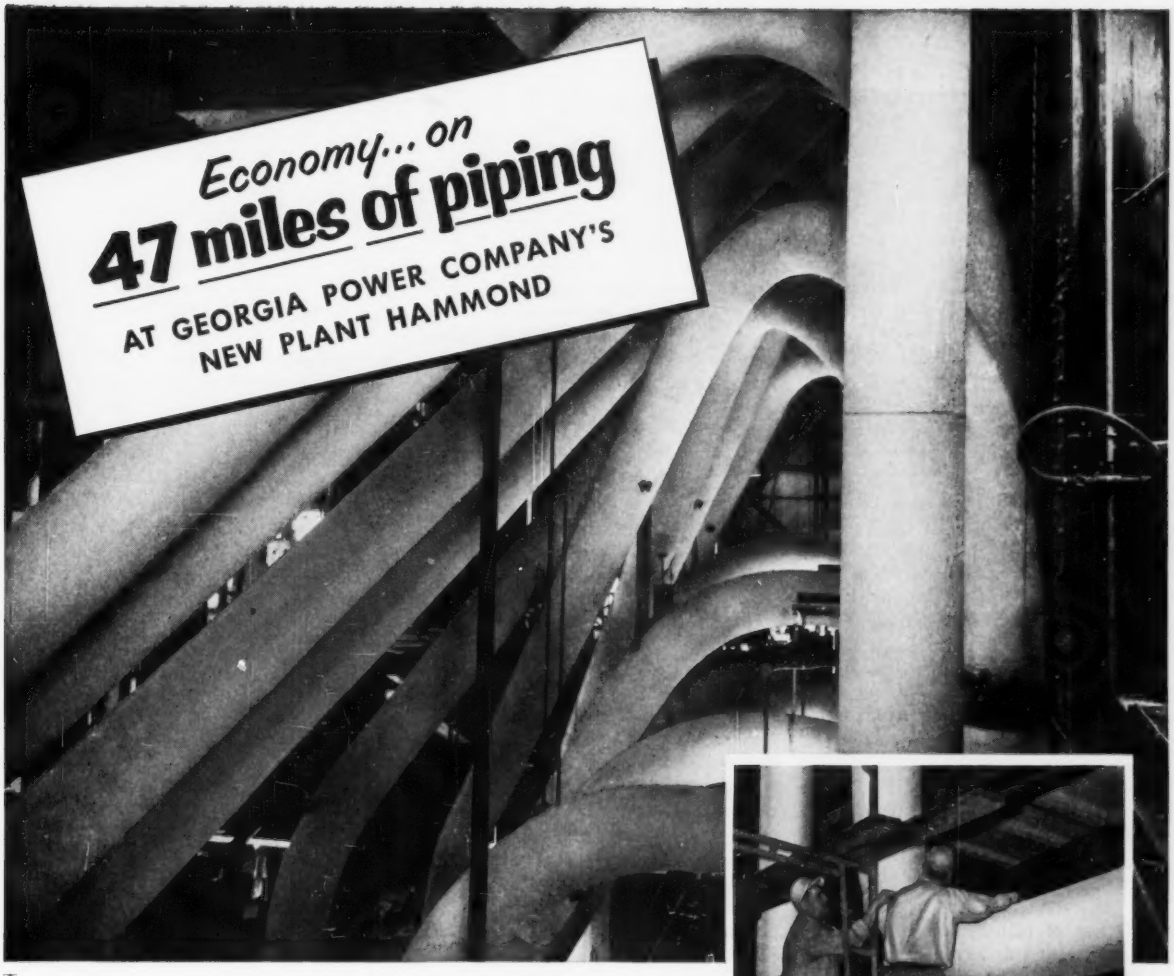
The question is divided into two parts: a comparison between grounded and ungrounded systems, and then what mode of grounding is best suited to the problem.

The author concludes that (1) Auxiliary systems at 4160 volts should be grounded to minimize multiple insulation failures. Added insurance against a first ground failure is a dividend. (2) Resistance grounding is preferred because of decreased fault damage, elimination of high voltage gradients and reduction of induced voltages in adjacent circuits. (3) Relaying for ground faults is as good or better for the resistor-grounded systems. *AIEE paper, No. 57-1099.*

The effect of fuel heating value on the economic loading of power systems. *By W H Guppy, Commonwealth Edison Co.*

This paper stresses the importance of determining the heating value of the fuel being used at each location in a power system, to allocate load to these locations for maximum system economy. It also describes briefly the technique used, and the difficulties encountered in sampling and analyzing the various solid fuels.

The author concludes that (1) In-



47 miles of Johns-Manville 85% Magnesia Insulation boosts operating efficiency of Plant Hammond, one of the South's largest and most modern private utility installations.

Insulating feed water line at Plant Hammond. Contractor for this job was Brooks-Fisher Insulating Company of Atlanta, Georgia.

J-M 85% Magnesia Insulation helps cut fuel rate 25% below national average

Officials of the Georgia Power Company were gratified when the coal rate of their new Plant Hammond worked out at 0.75 lb. per KW HR, 25% below the national average. In their annual *Electrical Industry Statistics, Electrical World* had reported that increased efficiency in the techniques of power production has lowered the average coal rate to 1 lb. per KW HR. in 1954.

An important factor contributing to Plant Hammond's high efficiency was the selection of insulation. Johns-Manville's 85% Magnesia was applied in the most economical thicknesses throughout the plant for all piping and equipment operating in its temperature range. At higher temperatures 85% Magnesia was used in combination with J-M Superex® diatomaceous silica insulation.

This is only one of thousands of case histories where J-M 85% Magnesia has helped industry achieve outstanding fuel savings and increased operating efficiency. In all types of manufacturing and processing plants it is the standard for temperatures to 600F . . . providing high insulating value, easy application, long life, initial low cost and minimum maintenance. Write today for further information on J-M 85% Magnesia and Johns-Manville's complete drawing-board-to-job-site insulation service. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

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Begins on page 178

cremental loading cost is a direct function of fuel heating value. (2) At any instant, fuel heating value probably is unknown, so that incremental fuel cost, and, consequently, incremental loading cost is in error. But over a long period, the author concludes, reasonable accuracy can be expected. *AIEE paper, No. CP-57-1059.*

Determination of the incremental heat rate characteristic by performance testing. *By R W Thomas, Southwestern Public Service Co.*

This paper presents the methods used by Southwestern Public Service Company to determine the unit incremental heat rate characteristic curve by performance testing. It describes the methods used in testing the single-boiler single-turbine type of unit and multiple-boiler multiple-turbine type unit. Various intermediate steps are shown in handling the data and the calculations required to produce the desired incremental heat rate curve from performance test data.

There are other methods for determining the unit incremental heat rate characteristic curve. These include use of manufacturer's specifications, operating data, and heat balance data. The author's company uses performance testing because types of metering used in plants lend themselves to this type of program; method also provides basic data for a comprehensive overall testing program; method is more easily understood by non-technical operating personnel who assist in carrying out the overall testing program. *AIEE paper, No. CP-57-1067.*

Recommended specifications for speed-governing of steam turbines intended to drive electric generators rated 500 kw and larger. *By Joint AIEE and ASME Committee on Recommended Specifications for Prime Mover Speed Governing.*

These specifications recommend minimum functional and performance characteristics relating to the speed-governing of steam turbines intended to drive electric generators that may, if desired, be included in prime-mover purchase specifications.

The specifications are limited in their scope to the following types of steam turbines, rated 500 kw and larger, and intended to drive electric generators at constant speed: (1) straight condensing, straight non-condensing and non-automatic extraction turbines without initial and/or exhaust steam pressure control. (2) Straight condensing, straight non-condensing and non-automatic extraction turbines with initial and/or exhaust steam pressure control. (3) Automatic extraction and mixed-pressure turbines. *AIEE paper, No. 57-1098.*

Basic data for load schedule development. *By F H Light, Philadelphia Electric Co.*

The elements of the electric production cost are: fuel, maintenance, labor and miscellaneous supplies and expenses. Two of these components are considered in development of the incremental energy cost: (1) The incremental fuel cost. (2) The incremental maintenance cost. Of these, the incremental fuel cost is of major importance and requires the most frequent adjustment.

The author breaks the problem into two parts: (1) Development of the master incremental energy cost loading curve for a single generating source. (2) Development of a cost adjustment factor to utilize the master curve for preparation of the daily system load schedule. Factors are discussed in detail. *AIEE paper, No. CP-57-1066.*

Atomic power

Engineering design of the EBWR facility. *By D C McClintock, Sargent & Lundy.*

Paper presents the general engineering features of the Experimental Boiling Water Reactor power plant at Argonne National Laboratory. It describes the plant arrangement, structural features, main mechanical systems, electrical system.

This project was designed from the beginning as a central station type of plant and was the first of several concurrent projects of similar purpose to start operation.

The experimental nature of the plant and the fact that it was a forerunner influenced engineering design. A number of more or less expensive safety precautions were incorporated to cover foreseeable hazardous situations that could possibly take place, and to provide a reasonable margin of safety to cover unpredictable contingencies. Undoubtedly operating experience and continued development work will prove that some of these precautions are not warranted. *AIEE paper, No. 57-1069.*

Special features of 5000-kw EBWR turbine condenser and pump. *By C H Morris, K H Gruenwald and C E Kenny, Allis-Chalmers Mfg Co.*

Although the EBWR flow cycle is fundamentally simple, the operating conditions with this type of steam generation required special consideration for several items. The steam delivered to the turbine is both saturated and radioactive. Since radioactivity of the steam is affected by the amount and type of impurities, materials were selected to minimize corrosion and erosion and, wherever possible, preference was given to materials with low radioactivation cross-section. Steam also contains an abnormally high free oxygen content because some of the water in the reactor decomposes. Oxygen content runs as high as 30 ppm.

Initial operation of the plant is being made with ordinary water. But the original design requirements were based on future operation with heavy water. This requires exceptionally tight sealing of all equipment.

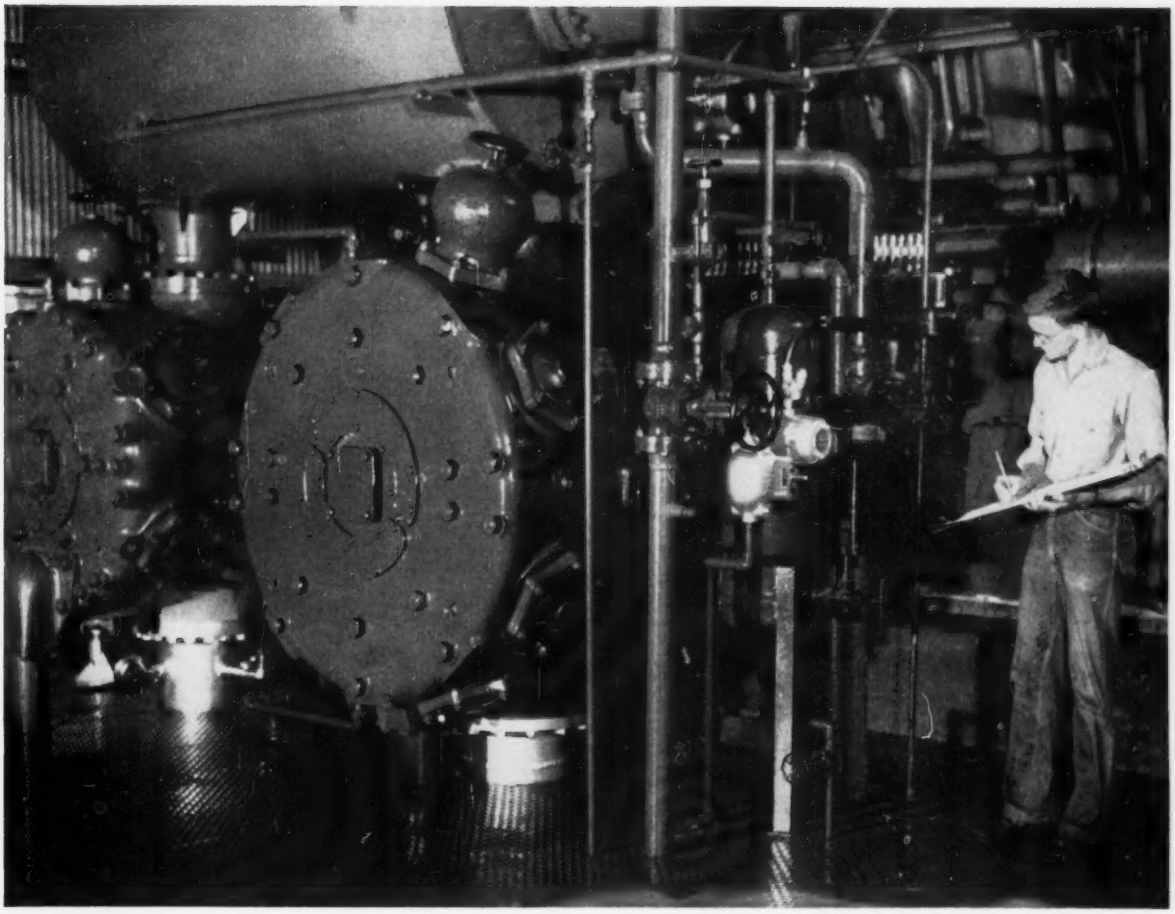
The reactor characteristics require close control of pressure in the steam generating space. Normal fluctuations of steam flows to the turbine with varying load, or sudden stopping of flow with tripping or loss of load cannot be tolerated. This requires a special pressure control, or by-pass system, interconnected with the turbine to maintain the flow of steam from the reactor constant at a controlled pressure regardless of turbine demand. Any by-passed steam is dumped into the condenser through a desuperheater. *AIEE paper, No. CP-57-1094.*

Load control for the Shippingport Nuclear Power Station. *By H A Van Wassen, Duquesne Light Co.*

This plant will use an unusual heat source consisting of a pressurized light water cooled and moderated heterogeneous, thermal type nuclear reactor. The reactor core will deliver approximately 300,000 kw of heat to the pressurized water (primary coolant) which in turn is circulated through a heat exchanger (boiler) to produce saturated steam at 600 psia on the secondary side. The

(*Continued on page* 240)

Directions for ordering papers on page 246



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LOW-VOLTAGE GROUPING shows 4-high breaker stacking

Circuit breakers are 1/3 smaller, 55% lighter

1201 • Low-voltage power circuit breakers and switchgear equipment have been revamped for improved performance, simplified operation and servicing and greater standardization, according to manufacturer. Breakers, 600-v units in 225-, 600- and 1600-amp frame sizes, are said to be first to have quick-make feature for manual closure of breaker contacts.

Units are 1/3 smaller, 55% lighter than old style. They have motor-driven stored-energy system for electric closure and easily interchangeable overload trips. Subassembly construction is said to cut parts-replacement and servicing time. Switchgear has closed-door drawout so breakers can be moved from operating to test and disconnect positions within enclosure without opening cabinet doors.

Reduction in breaker size permits four-high stacking of 600-amp breakers in standard 90-in. high enclosures.

Units are designed for commercial-building, industrial-plant and power-station applications, for switching, control and protection of motors, generators, transformers, feeder circuits and other large equipment. Other features include: motor-driven stored-energy system, interchangeable overcurrent trips, arc chutes which double arc back down to exhaust at side of unit rather than at top to permit use of arc-chute units half as high as usual.

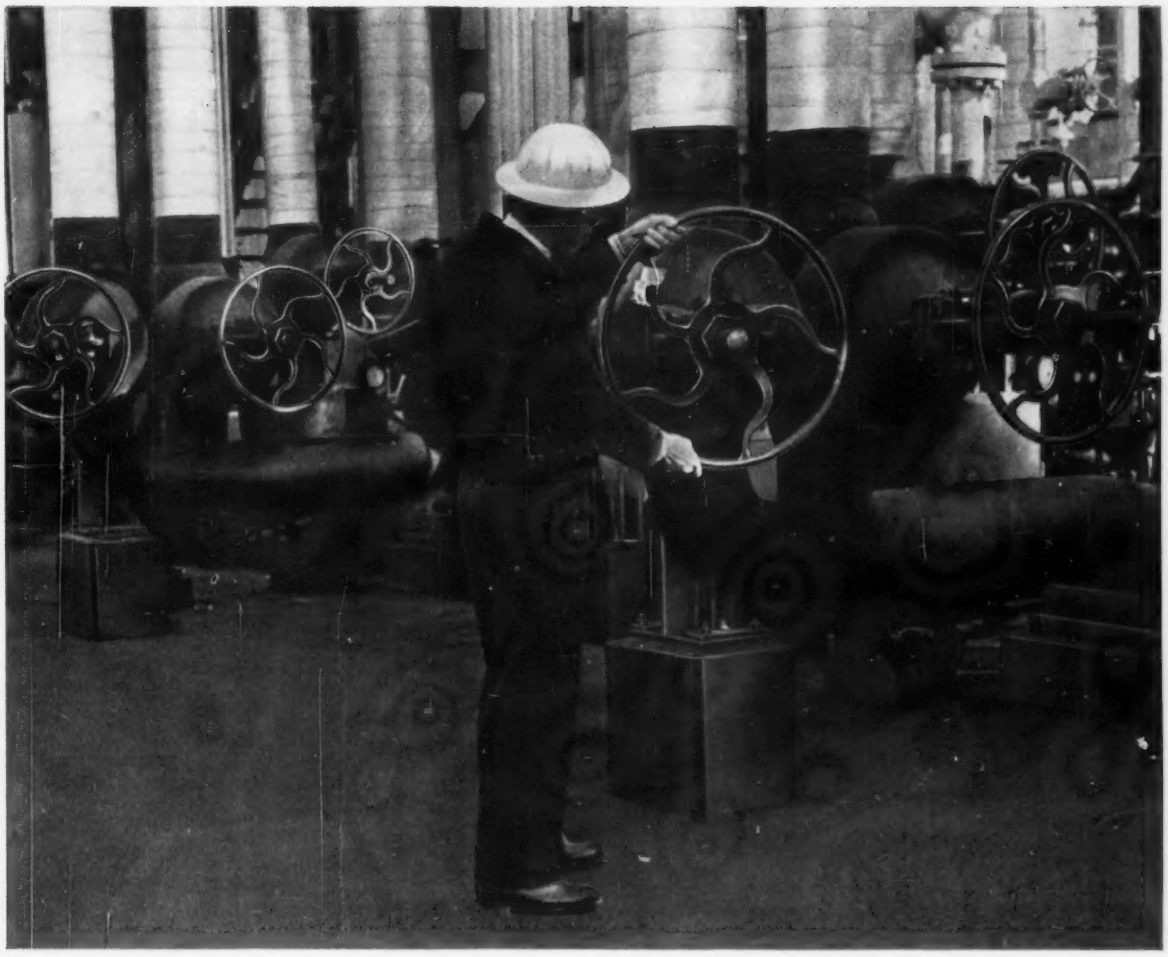
I-T-E Circuit Breaker Co, 1900 Hamilton St, Philadelphia 30, Pa.

ACCESSIBLE TRIPS for adjustment ease are mounted three on one molding

BREAKER can be moved to test and disconnect positions while door is closed

QUICK-MAKE manual closure works by spring action, helps eliminate arcing

For more data on these items, use post cards on page 191. Identify your request with item number



No repairs, no maintenance for these Crane valves —after 12 years on feed-water service

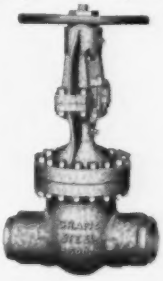
The day these Crane steel valves were installed 12 years ago, they started saving money for the Neches Butane Products Company's butadiene plant in Texas.

Not once have these 8-inch No. 76½ XR steel gate valves required repairs—not once have they needed maintenance . . . and they've been on hard, continuous service on lines to boiler feed pumps in this 3 million pound-per-hour steam plant.

There's more than meets the eye to valve service like this. From the outside, the average person wouldn't know the difference between Crane valves and others of the same type. That's why those who know valves investigate the *inside* quality before they specify. When the valves are Crane, they don't have to look far to find this quality—quality in materials, engineering and construction that literally means the difference between long, cost-free performance and expensive, aggravating, down-time maintenance.

Don't take chances with your all-important valves. Specify Crane, and make *sure* of getting service you can depend on—with the world's most complete line to select from, backed by a century of unparalleled experience in serving industry.

Get full information from your local Crane Representative, or write to address below.



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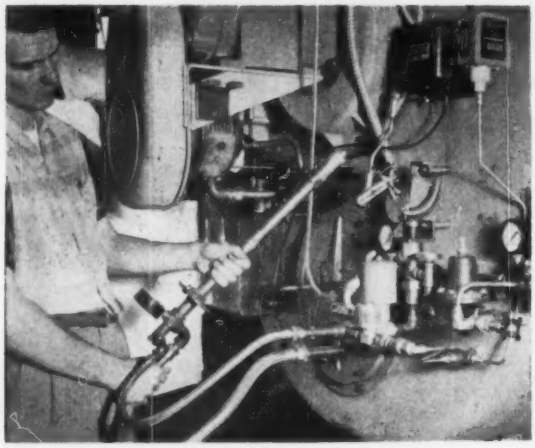
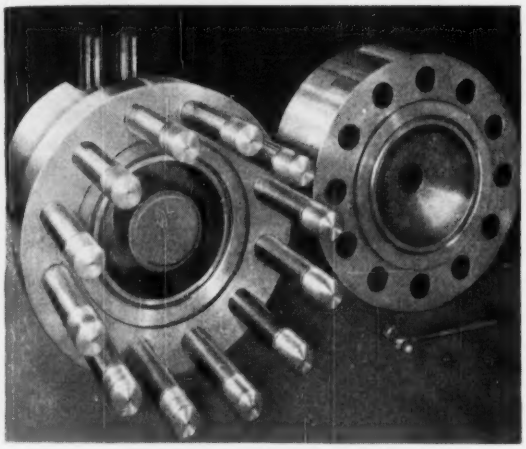


Retractable nozzle speeds cleaning

1202 • Feature of boiler line is single-tip retractable burner nozzle which simplifies cleaning, manufacturer claims. Unit is equipped with flexible lines which allow inspection without removal of bolts. Single-tip design is said to offer stable combustion and positive mixing action of oil and air.

Boilers also incorporate 4-pass, forced draft and updraft construction. Units have five sq ft of heating surface per boiler hp. Vibrationless impeller mounted directly on blower motor shaft is said to provide quiet operation, since sound is muffled within front head. **Cleaver-Brooks Co, 493 E Keefe Ave, Milwaukee 12, Wis.**



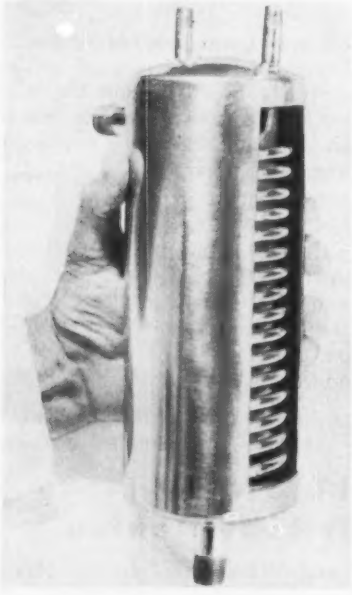
High-pressure purifier takes 15,000 psi

1203 • Purifiers for air, steam and process vapor and gas line use are designed to withstand pressures to 15,000 psi, with 12,050-psi maximum service pressure.

Pressure parts are of alloy steel with special gaskets and pipeline connections. Units must pass ultrasonic and hydrostatic tests and strain-gage analysis for deformation, according to manufacturer.

Unit has no moving parts, filters or mesh screens; operates by 2-stage principle using centrifugal force to guide entrainment-laden vapor through a series of vanes and baffles. Largest pressure-vessel unit to date is six in. **The V D Anderson Co, 1935 W 96 St, Cleveland 2, Ohio**

For more data on these items, use post cards on page 191. Identify your request with item number



Heat exchanger cools liquids at 5000 psig, 1200 F

1204 • Small-sized heat exchanger is designed for use with pressures up to 5000 psig, temperatures to 1200 F. Shell and tubular-coil type unit is said to be applicable to feedwater heaters, hot-water softeners, high- and low-pressure boilers in nuclear and conventional power plants.

All parts of cooler are joined by welding. Unit is housed in a stainless-steel shell 3½ in. in diameter x 11¼ in. long. Sample pipe and circulating water connections are made externally to avoid possibility of sample contamination from leaky joints, fittings.

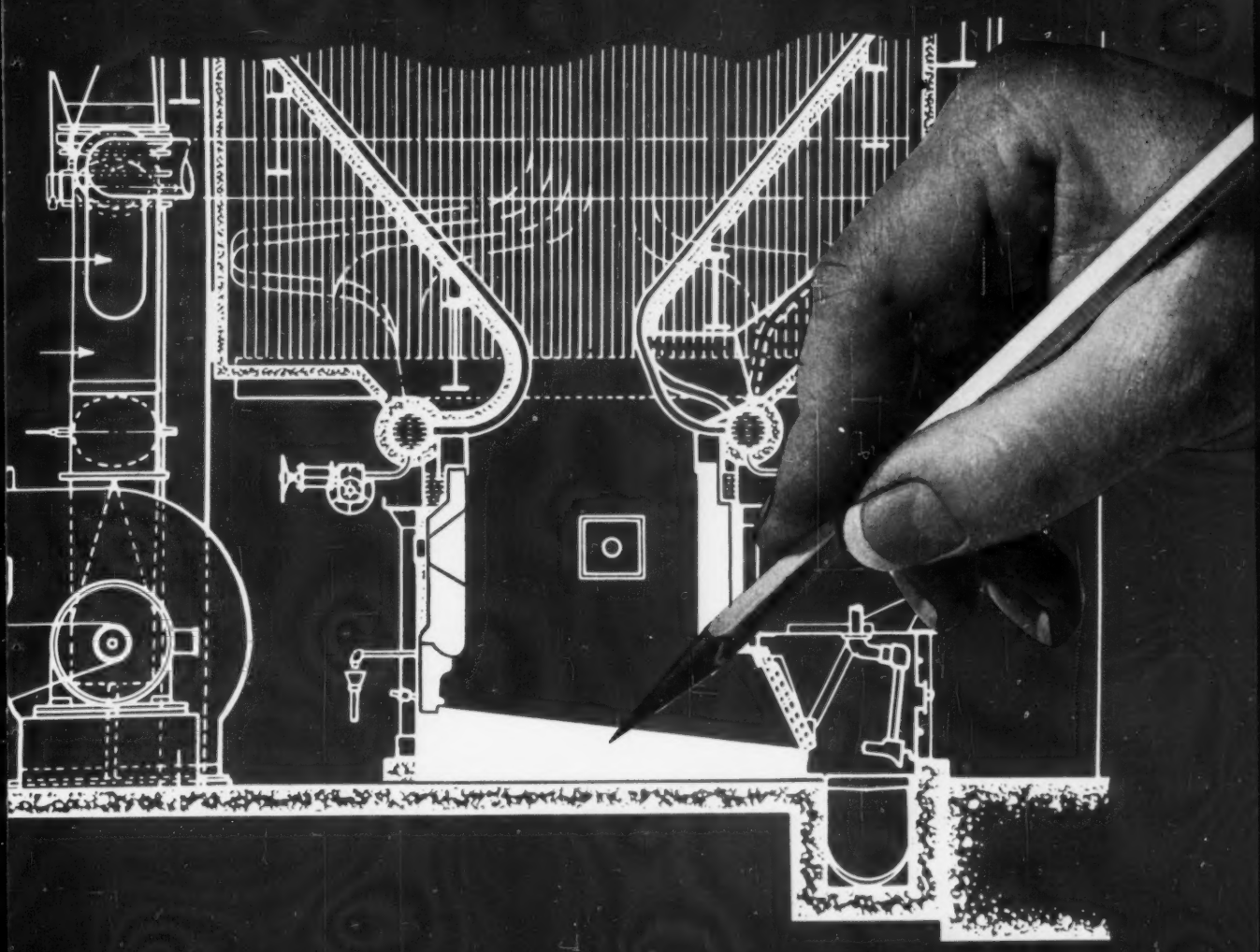
Cooler is fitted with ¼-in. 20-gage type-316 welded stainless tubing for pressures to 3500 psig and temperatures to 700 F; with 20 Cb tubing for higher pressures and temperatures. Shell consists of type-304 stainless welded tubing, 3½-in. OD, 16 gage. Dished heads of type-304 stainless are die formed, welded to both ends of tube.

Unit has ⅛-in. IPS threaded nipples welded to inlet and outlet extensions of coil. Wall thickness of nipples, coil and shell are similar to permit pressure-tight welding of joints and maximum flow efficiency. Unit is said to feature counterflow principle making possible cooling of liquid samples to temperatures approaching those of inlet cooling media. Flow passages are designed to promote high rates of heat transfer and to eliminate short circuiting or pocketing of sample and coolant. Adequate surface is said to insure good flow rates.

Although ASME *Unfired pressure vessel code* does not specifically cover unit, strength of tubular components meets requirements of the *Code* at operating temperatures, maker claims.

The Carpenter Steel Co, Alloy Tube Div, 133 Springfield Rd, Union, N. J.

How to draw the line on ashpit maintenance



"Let's put Kaocrete here"

Relining ashpits is expensive and time-consuming. That's why more and more utilities and industrial companies are specifying a heavy-duty refractory castable such as B&W Kaocrete D. On job after job, it has withstood the heavy abrasive or erosive attack of sprays, jets, rakes or shovels.

The reason? Specially designed Kaocrete D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It saves time because it can be poured or gunned into place. For less severe abrasive or erosive conditions, B&W recommends Kaocrete A.

Get the facts and figures on these B&W Refractory Castables from your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

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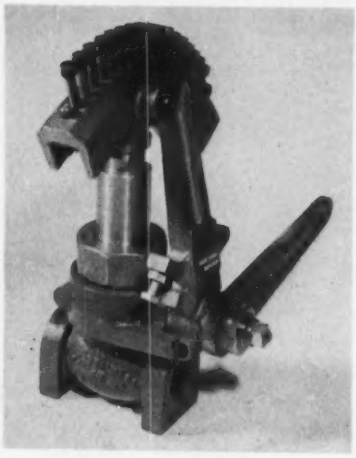
R-39

Begins on page 182

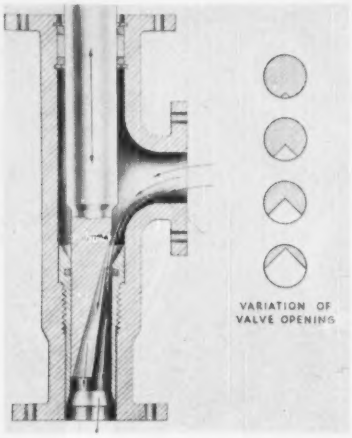
Plant valving problem? Check these six items



Lever-operated valve

1205 • Adjustable-cam lever-operated unit is designed for metering control of fuel oil in industrial oil-burner installations. Unit maintains flow ratio between two variables such as air and fuel oil into oil-fired steam boiler. Features include seats with 3/8-in. diameter bore in single seated valves; interchangeable parts, adjustable lever.

Atlas Valve Co
280 South St, Newark 4, N. J.



Valve has tapered orifice

1206 • Tapered-orifice unit is said to offer new concept of flow control. Fluid or gas flow is regulated by a plug with tapered slot moving into and out of a circular opening. Circular sealing ring eliminates by-pass. Advantages are said to be accuracy, variable control, nonclogging, nonfreezing good coefficient of flow with low turbulence.

General-American Valve Co
Box 444, Corona del Mar, Calif.

Diaphragm-operated valve

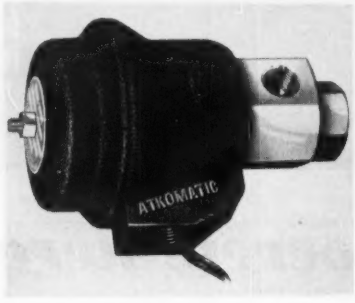
1207 • Control valve is said to have ductile iron body for hot-water service at pressures up to 600 psi, temperatures to 350 F. Stainless-steel stem, replaceable seat inserts give leak-free service, according to manufacturer. Skirted seat rings resist wire drawing. Valves come in 2-way and 3-way normally open or normally closed types.

Sinclair-Collins Valve Co
454 Morgan Ave, Akron 11, Ohio

Shuttle valve

1208 • Unit is designed for charging and discharging of pressure cylinders through actuation of any one of two or more 3-way valves located at remote control stations. Feature is said to be "anti-extrusion" arrangement providing airtight service and eliminating danger of ring-seal cutting in normal operating pressure range.

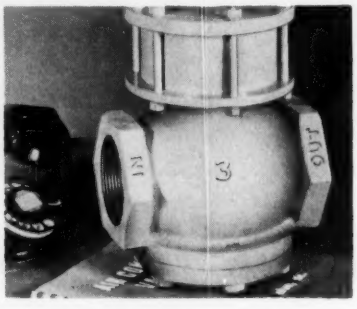
Versa Products Co Inc
249 Scholes St, Brooklyn 6, N. Y.



Stainless solenoid valve

1209 • Stainless steel unit is for control of high-pressure corrosive gases and fluids. Unit is a direct-lift type machined from 316 stainless steel barstock rated to 600 psi. Valve comes in 1/8-, 1/4-, 3/8- and 1/2-in. sizes. Port sizes depend on pressure and viscosity of medium. The valve can be supplied with an explosionproof housing.

Atkomatic Valve Co Inc
545 W Abbot St, Indianapolis 25, Ind.



Pilot-operated valve

1210 • Line of 2-way units comes in pipe sizes from 1½ through 3 in. Normally closed or normally open valves can be used with air, oil, water or vacuum at pressures of 0 to 500 psi. Units have only one moving part, assure positive bubble-tight shutoff and are completely noncorrosive, self-compensating and compact, according to maker.

Airmatic Valve Inc
7317 Associate Ave, Cleveland 9, Ohio

For more data on these items, use post cards on page 191. Identify your request with item number

Turbines Get Acid Stomach, Too!

But Cities Service Has The Cure

As they steam through the day, turbines, like people, develop dangerous acid in their systems.

Unless controlled by a properly, highly fortified lubricant such as Cities Service Pacemaker-T Oil, this acid will contribute to sludge formation and attack the metallic surfaces inside the turbine.

Guarding against acid and sludge is just one of many important protective jobs done daily by Cities Service Pacemaker-T Oil. In addition, this superior lubricant provides unsurpassed anti-foam and anti-rust protection plus maximum oxidation stability and water separation.

There's a Cities Service turbine oil for every kind of turbine, every type of oiling system. Ask your Cities Service Lubrication Engineer for details. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

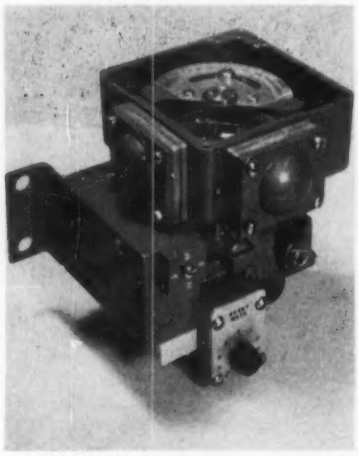
CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

More EQUIPMENT NEWS

Begins on page 182

Controller features proportional band adjustment



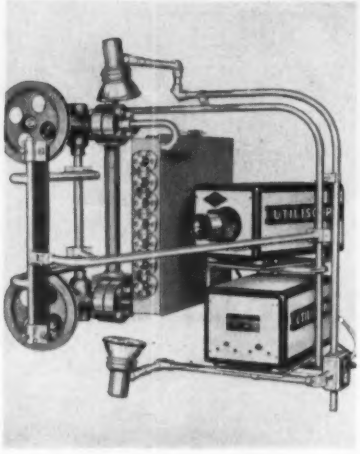
1211 • Type *VC* pneumatic controller is said to have band adjustment from 2 to 500% and less than 0.05% dead band, as well as either remote pneumatic or local spring set-point adjustment. Unit design is based on null-balance-vector principle.

Proportional band of controller is changed by loosening a lock screw and moving it along a scale. Reset rate is 0.1 to 50 repeats per minute.

Units come for panel or post mounting; can be furnished with weatherproof cover. Standard pressure ranges for feedback, pneumatic set point and output are 3 to 15 psi. Air supply required is 0.2 cfm at 18 to 20 psi.

Republic Flow Meters Co
2240 Diversey Pkway, Chicago 47, Ill.

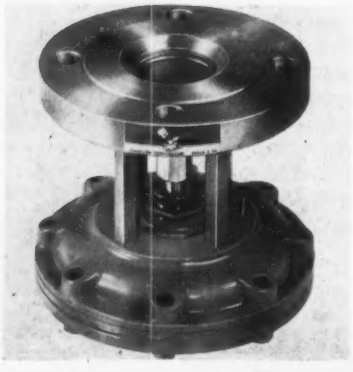
Closed-circuit TV comes packaged with two-color gage



1212 • Package permits quick, easy installation of industrial TV to watch multiport or continuous-vision water-level gage. Gage connections are furnished to the requirements of drum, rest of package is permanently mounted on gage. Gage is read on viewing screen; water showing black, steam white. Other advantages claimed by manufacturer: space is saved and gage is fully accessible for maintenance; mirror assembly swings out of the way when only one cap screw is loosened; maximum safety in case of gage leakage is provided by indirect-viewing mirror. Use Reader Service post cards, p 191, to obtain complete information.

Diamond Power Specialty Corp
Lancaster, Ohio

Liquid-level transmitter



1213 • Pneumatic unit measures pressures as high as 250 psi and liquid level ranges from 0 to 100 in. Operating on force-balanced principle, model transmits linear 3 to 15 psi signal to recorder, indicating gage or manometer. It can be mounted horizontally or vertically on open or closed tanks. Design is said to eliminate possibility of measured material backing up into air lines in case of diaphragm rupture.

Conoflow Corp
2100 Arch St, Philadelphia 3, Pa.

Operations recorder

1214 • High-speed sequential operations recorder is designed for use at electrical power generating stations and unattended substations. Designated the *MOR* system, it automatically records digital-tape-log sheet. Sheet is useful in evaluating normal operations and in analysis of upset conditions. Time differences of 10 milliseconds between events are said to be easily distinguishable on printed digital tape.

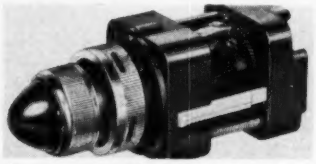
System operates from regular station trouble contacts. Contact need not be limited to type on protective devices; it can be any contact which reflects on or off states. Standard 3-in. recording tape is printed with date and time of event, number of trouble contacts involved and direction of change.

Individual relay devices per point are not required, according to maker. Only channel equipment employed is passive, involving no mechanical motion. Unit is completely transistorized and employs no hot tubes.

When trouble contact opens or closes, electronic "number" and on or off signal are fed to printer. Then, (1) identifying point number is printed (2) real time of event is printed (3) tape is set in motion (4) timing track is imprinted once each cycle marking tape at intervals of 16 milliseconds (5) tape continues to run for 12 sec beyond last event. System can handle any number of inputs up to 400 points.

Fischer & Porter Co
253 Jacksonville Rd, Hatboro, Pa.

Don't miss this item . . .

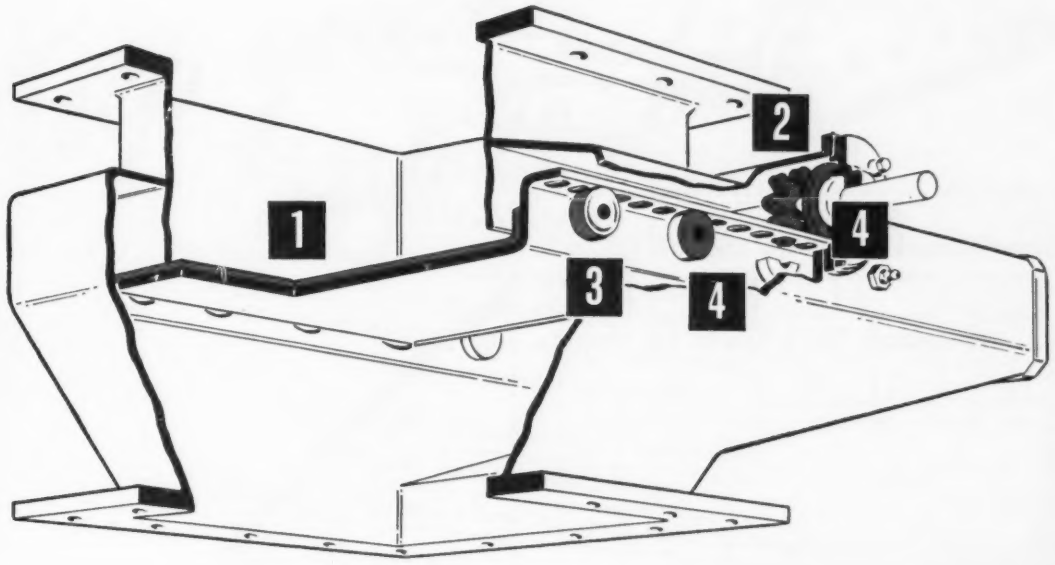


Push-to-test pilot light . . . . p 198

. . . or other product news appearing on following pages

Saw-drill combination . . . . p 196
Demineralizer . . . . . p 196
Magnetic insert finder . . . . p 198
Potential transformer . . . . p 200
Heavy-duty trigger switch p 200
Wire strain relief . . . . . p 202
Mechanical brake motor . . p 204
Belt-driven duct fan . . . . . p 204

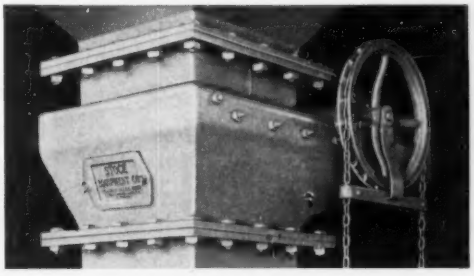
For more data on these items, use post cards on page 191. Identify your request with item number



The inside story

ON THE S·E·CO COAL VALVE . . .

STAINLESS STEEL



Wherever you find coal you find corrosion—or the possibility of corrosion. And wherever you find corrosion you find valves that stick, are hard to operate and that will soon need replacement.

Stainless steel resists corrosion — makes valves that are easy to operate and that have a much longer life. That's why Stock Equipment Company has made stainless steel a *standard material* for certain vital parts of the S-E-Co. Coal Valve.

Take the deep U-shaped gate, for instance. The stainless steel liner (1) on top combats corrosion. This not only means longer life, but by preventing pitting it reduces friction when closing against a head of coal.

Multi-faced pinions (2) located above the self cleaning racks are also of stainless steel. By withstanding corrosion the thin pinion sections maintain their strength and are thin enough to make racks and pinions truly self-cleaning.

In addition, stainless steel is used for the shells of the gate-supporting rollers (3) and for the grease seal retainer rings on roller and shaft bearings. (4).

For dependable, efficient valve operation, get S-E-Co. Coal Valves which feature stainless steel as a standard material. If you have a particularly severe problem of corrosion, Stock Equipment Company can help insure normal operation and long life by making the valve body itself entirely of stainless steel.

STOCK Equipment Company

745-P HANNA BLDG. • CLEVELAND 15, OHIO

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by agreement with

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is pleased to announce that it now has
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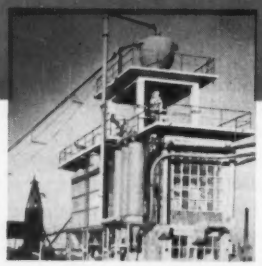
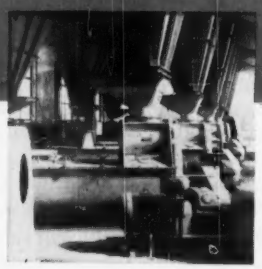


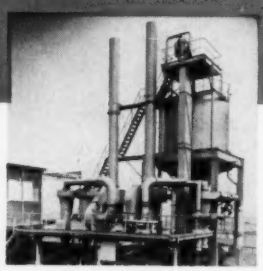
PNEUMATIC CONVEYING

Hartmann has designed, fabricated and installed over 1000 systems for more than 200 different industrial applications. The first, in 1903.



MECHANICAL CONVEYING

In belt, screw, chain, plate and bucket types — experienced in standard and special applications and in combination with pneumatic systems.



DUST REMOVAL SYSTEMS

Fluor-Hartmann designs wet or dry types or combinations of both for critical industrial applications ranging from de-dusting to air sifting.

Sales Offices in: Birmingham, Buffalo, Chicago, Denver, Detroit, Houston, Kansas City, Los Angeles, Minneapolis, New York, Philadelphia, Pittsburgh, San Francisco, Tulsa, Toronto, Ontario

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AIR CONDITIONING, HEATING, REFRIGERATION, VENTILATING

1 **Steam-heating coils** are discussed in 26-p illustrated booklet B-1710. Contains pictures, descriptions of commercial and industrial coils, piping diagrams, performance and selection tables. Westinghouse Sturtevant Div, Dept T-371, 200 Readville St, Hyde Park, Boston 36, Mass.

2 **Blower utility sets** are subject of 52-p 2-color catalog 8314. Illustrates and describes size ranges and configurations of fan wheels and motors. American Blower Div of American-Standard, Tireman Ave at Roselawn, Detroit 32, Mich.

3 **Electric-heater hook-ups,** heat-requirement nomographs for storage tanks handling viscous fluids are discussed in 8-p supplement 202A. Schematics and installation photos included. Hynes Electric Heating Div, Turbine Equipment Co, Mountainside, N. J.

4 **Propeller-fans** catalog A-109C has 32 pages, contains revised air-delivery information, specs, performance data and dimensional drawings. Utility and cool-blast fans shown. Hartzell Propeller Fan Co, Piqua, Ohio.

5 **Dust control** is discussed in 16-p illustrated bulletin 274B. Explains features, has wiring diagrams, tables, dimensions. American Air Filter Co, Inc, 215 Central Ave, Louisville, Ky.

BOILERS AND AUXILIARIES

6 **Two-drum boilers** are described in 12-p catalog SB-58. Improved features described; design, construction and application information given. Erie City Iron Works, 912 W 12th St, Erie, Pa.

7 **Safety controls** for 1-p steam boilers are covered in 24-p book. Contains detailed diagrams. Discusses controls for all types of boilers. McDonnell & Miller Inc, 3500 N Spaulding Ave, Chicago 18, Ill.

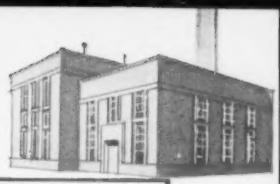
8 **Steam-trap** folder contains six pages, including tables and diagrams for selecting traps for any condensate-discharge condition. Has installation data. Crane Co, 836 S Michigan Ave, Chicago 5, Ill.

9 **Selection survey** form lists suitable boilers for different applications. 6-p form describes electrical supply, type of fuel to be used, boiler-room size, feedwater. Orr & Sembower, Inc, Reading, Pa.

CONTROLS, ELECTRICAL & MECHANICAL

10 **Molded-case circuit breakers** in ratings of 15 to 800 amps are sub- (*continued on p* 230)

Midwest institution gets lesson in turbine lubrication



. . . *learns advantages of using* NONPAREIL *Turbine Oil*

In 1939, a Midwestern institution installed a 350 kw. turbine. In less than a year, considerable difficulty was experienced with oil sludge and deposits. A Standard Oil Company industrial lubrication specialist recommended switching to NONPAREIL Turbine Oil as a solution to the problem. He supervised the draining and cleaning of the turbine system and the installation of NONPAREIL Turbine Oil.

The turbine, equipped with NONPAREIL, was started up in June, 1941. Periodic tests showed that the neutralization number of the oil was never above 0.06 mg. KOH/g. Having had this experience with NONPAREIL Turbine Oil, when a new 750 kw. turbine was installed in 1947, only NONPAREIL was considered. In 1954 when a 1,000 kw. turbine replaced the 350 kw. one installed in 1939, NONPAREIL was again the first choice of the institution management.

The reason why NONPAREIL can deliver this kind of performance is this: NONPAREIL is refined from finest quality oil. An oxidation inhibitor is added to NONPAREIL which checks acidity formation even better than natural inhibitors normally found in oil. The inhibiting of acid formation in NONPAREIL is so complete Standard Oil can guarantee that the neutralization number of NONPAREIL Turbine Oil will never exceed 0.15 mg. KOH/g. for the life of the turbine.

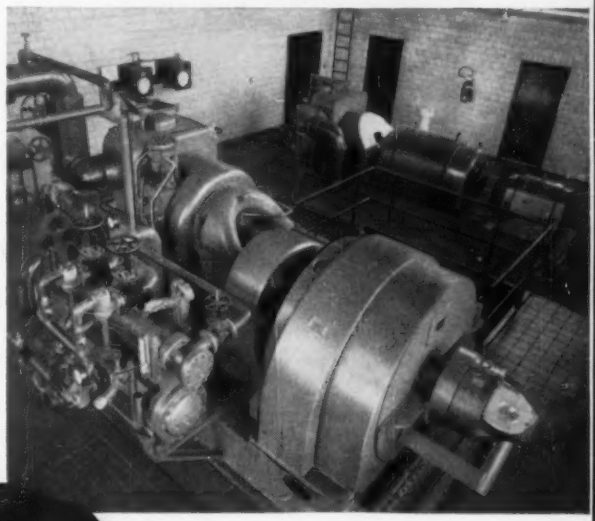
More facts about NONPAREIL Turbine Oil are readily at hand. Get them from your nearby Standard Oil industrial lubrication specialist. There is one of these men in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

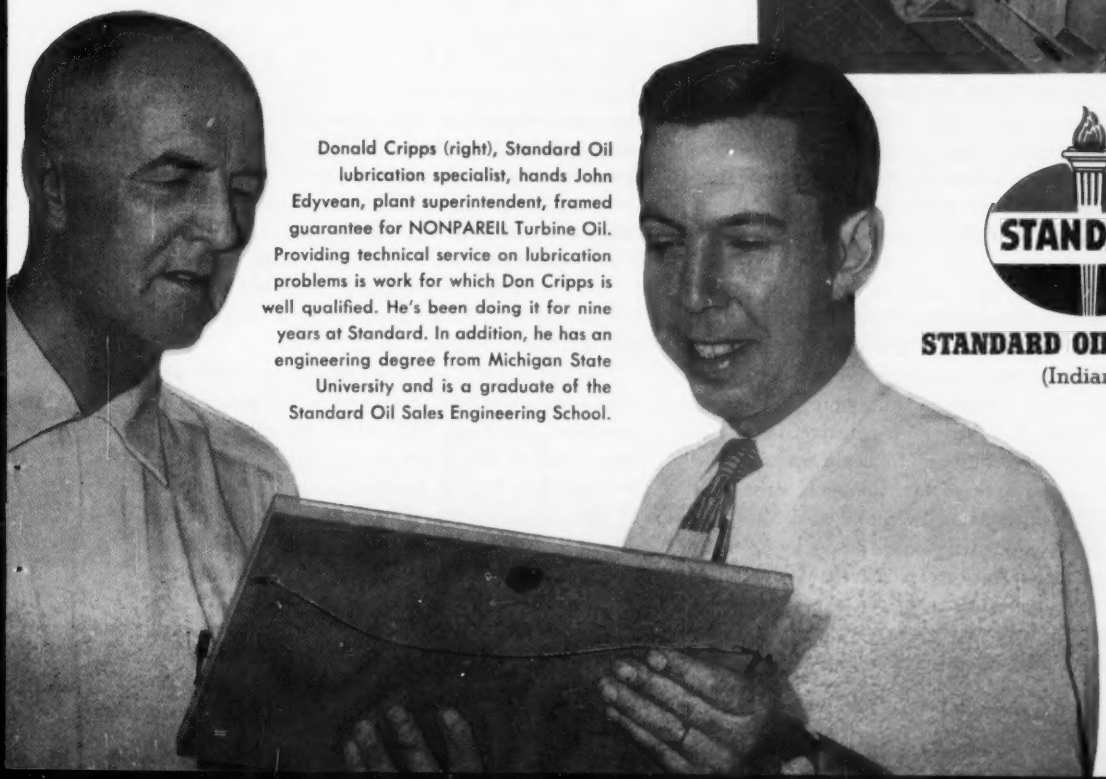
Quick facts about

NONPAREIL TURBINE OIL

- Does not form acids.
- Does not sludge.
- Maintains good demulsibility.
- Guaranteed to last the life of the turbine.

A 1,000 kw. and a 750 kw. turbine provide power to this Midwest institution. Both have used NONPAREIL Turbine Oil since the first day they went into service.





Donald Cripps (right), Standard Oil lubrication specialist, hands John Edyvean, plant superintendent, framed guarantee for NONPAREIL Turbine Oil. Providing technical service on lubrication problems is work for which Don Cripps is well qualified. He's been doing it for nine years at Standard. In addition, he has an engineering degree from Michigan State University and is a graduate of the Standard Oil Sales Engineering School.

STANDARD

STANDARD OIL COMPANY

(Indiana)

George Edwards

says you can be time's master or slave

► IN A FEW MORE WEEKS we'll all be seeing once more those familiar drawings of the little fellow in a diaper pushing the old greybeard out of the picture. I've always liked this graphic portrayal of time's passing because it depicts *progress* as well as just another calendar year gone by.

To some, the "I'll never get this done in time" group who live under the shadow of Robert W Service's dismal "It is later than you think", it means that time is flying.

To others, the "I just don't know what to do with myself" bunch, about all the new year means is that they'll be putting a higher number on their letters.

A good many people, however, see in the picture a chance to make even more use of the upcoming 365 days than they did of the ones represented by the tired old man.

When you come right down to it, there isn't any more difference between Dec 31st and Jan 1st than there is between the last and first days of any other two months. But there are mighty few people who don't even get a temporary lift out of the magic phrase, "Happy New Year!" It's instinctive at this time to make "resolutions" to come up with the best year of our lives so far. Common sense tells us that while an ingrained habit is hard to break, it can be done if we *really* want to.

Time can be our hard-working servant or a tough boss. And we have to decide for ourselves which it'll be. If we "never have enough time"—and are honest with ourselves—maybe we're trapped in the hourglass because we fiddle a lot and don't get down to brass tacks until the last possible minute. If we're in the "static" crowd — not interested in anything in particular—let's not kid ourselves. We're just marking time between now and the grave, and probably doing a lot of brooding that only makes us feel worse mentally and physically.

On the other hand, we've got people who are too busy to worry about time or to be unhappy. Take a guy we'll call Joe Jones. We all know a Joe Jones. He's at the plant a few minutes early every day and is usually so busy that quitting time rolls around before he knows it. Off the job, he has a finger in a lot of community projects. During sandlot baseball and football seasons, you'll find him coaching, umpiring or taking care of the kids' bumps and scratches. During the winter, kids meet in his basement for popcorn, cokes and gab. He has as little spare time as anybody we know—and gets more done with it.

You can shoot a few holes in any argument and mine's no exception. Sure, we're all pressed for time now and then. And maybe we all develop a lazy streak at times. But, by and large, you'll have to admit that the Joe Joneses seem to get a lot out of life and don't wear themselves to a frazzle in doing it. They have the knack of making every minute count not only in doing what they *have* to do, but in the things they *want* to do.

Here's wishing each of you a Merry Christmas and the *busiest* New Year you ever had.

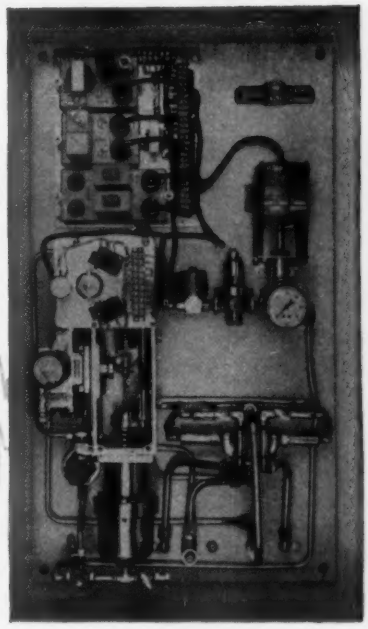
NOW! Cash Standard-Sparton brings you the World's First

Packaged Remote Control System

regulates final control elements governing

- **PRESSURE**
- **FLOW**
- **SURGE**
- **PROPORTIONING**
- **LIQUID LEVEL**
- **SPEED**

and other process variables



SUPERVISORY CONTROL UNIT

For remote location at distances of a few feet to many miles. Operates on telephone, telegraph, private lines or microwave.

Now—for the first time in a single package system—it is possible to control, from a distance of many miles if necessary, the positioning of cone, butterfly, plug and ball valves; sliding stem valves; throttles, rheostats and other variable speed mechanisms; and similar final control elements.

The unique Series 300 Packaged Control System, developed by A. W. Cash Company and Sparton Corporation, reduces operating costs substantially through regulation of final control elements by one operator from one central point. As a result, the equipment pays for itself rapidly. It is recommended particularly for such applications as pipe lines, pumping stations, oil wells, storage tanks, power stations, municipal water distribution, petroleum and chemical processing and atomic energy processing.

For complete information on the remarkable new Cash Standard-Sparton Series 300 Packaged Control System, see the Cash Standard control specialist in your area, or write to Dept. E.

CASH **CS** **STANDARD**

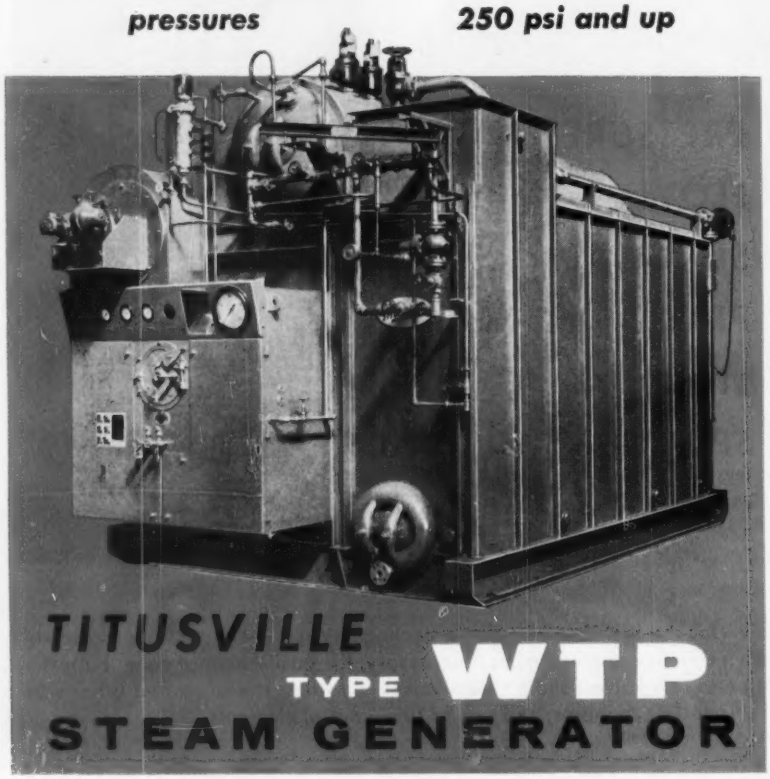
A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.
P. O. Box 551, Decatur, Ill.

Pressure, Hydraulic, Temperature, Process and Combustion Controls

PERFORMANCE

Meeting Your Most Rigid Requirements—in Capacities to 60,000 lbs.

pressures *250 psi and up*



TITUSVILLE TYPE WTP STEAM GENERATOR

Tops in steam generating performance is matched by outstanding dependability in Titusville's Type WTP Water Tube Steam Generators. Completely factory-assembled, ready to ship by flatcar or truck trailer, Type WTP is easy to install in your boiler-room. • Let us show you why and where Type WTP is serving many of the toughest boiler assignments in the country. When writing, ask for Bulletin 5511.

THE TITUSVILLE IRON WORKS CO.

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BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

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TITUSVILLE, PENNSYLVANIA

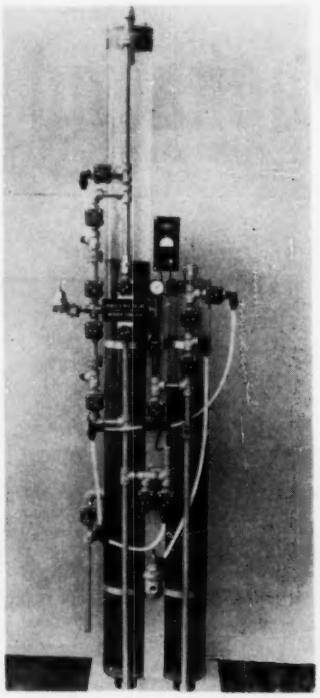
Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement

Plants at Titusville, Pa. and Warren, Pa.

Offices in Principal Cities

More EQUIPMENT NEWS

Begins on page 182



Demineralizer

1230 • Unit features cast-acrylic columns for carbon-filter column and ion-exchange column. Operating on mixed-bed ion exchange principles, unit produces up to 100 gph of tasteless odor-free water, according to manufacturer. Mono-column unit comes completely packaged. Exchange capacity of resin charge is 18,000 grains; unit's overall dimensions are 15 in. x 15 in. x 86 in. Controls for automatic operation are optional. Request details.

Penfield Manufacturing Co
19 High School Ave, Meriden, Conn.

For more details on these items, use post cards, p 191. Identify your request with item number.

Saw-drill combination

1242 • Combination model converts from drilling to sawing simply by turning knob from drill position to saw position, according to manufacturer. Capacity of drill is ¼ in. Stroke of saw is ½ in.; unit is said to cut ¼-in. hot roll plate 1 in. per min.

Comes with ¼-in. geared chuck for smaller than ¼-in. drills and four saws

Packaged Ljungstrom® Preheaters increase efficiency for boilers as small as 25,000 lbs per hour! Money spent on fuel in a single year often equals the cost of the boiler itself! And with fuel prices continually rising, every BTU is doubly precious.

So don't let fuel dollars go up the stack—in smoke. Whether your boiler produces 25,000 or 250,000 pounds of steam per hour, the shop-assembled Ljungstrom preheater recovers heat—and dollars. Results: FUEL CONSUMPTION IS REDUCED! Generally 10% or more. This will usually write off the cost of a Ljungstrom in less than 2 years.

BOILER PRODUCTION IS INCREASED! By preheating air, higher temperatures in the furnace are assured, higher heat absorption and steam producing capacity are made possible.

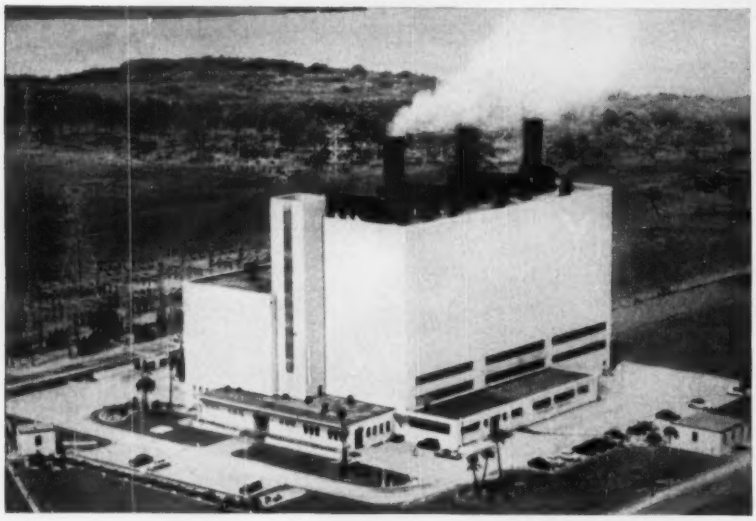
LESS MAINTENANCE NEEDED! Improved combustion means less slag, cleaner stack gases. Thus you benefit from fewer overhauls; longer service between shutdowns.

LOW GRADE FUELS PRACTICAL! Higher furnace temperatures permit effective burning of very low grade fuels.

COMES READY TO INSTALL! The Ljungstrom is shop-assembled, is easily applied to your steam-generating units. For details, contact The Air Preheater Corporation today. Ask for our free brochure.

The Air Preheater Corporation, 60 EAST 42ND STREET, NEW YORK 17, N. Y.

ENGINEERING . . .
makes the difference



Kuljian projects like these are engineered—and custom-built—with a practical knowledge of modern power development. They combine balanced design . . . selection of equipment properly arranged and assembled . . . and are pre-planned to assure maximum flexibility and capacity for meeting the heaviest load requirements. To owners of electric utilities or industrial power plants, Kuljian offers a wide range of power engineering services plus an experience record spanning *twenty-seven years.*

Whether your project calls for engineering only . . . for construction only . . . or for the combined services of engineering *and* construction . . . Kuljian assures you of efficient and economical handling of any phase, from feasibility reports through initial operation.

The **Kuljian** *Corporation*

engineers • constructors

1200 North Broad Street • Philadelphia 21, Penna., U. S. A.

More EQUIPMENT NEWS

Begins on page 182

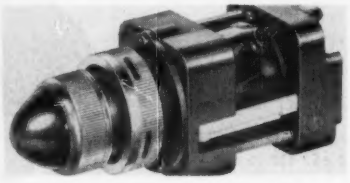
for standard equipment. Eight other saws are optional equipment.

Modern Mfg Co Inc, 680 Davisville Rd, Willow Grove, Pa.

Magnetic insert finder

1222 • Unit is designed to find underfloor distribution systems when additional floor outlets are to be installed. Made of brass with black-crackle finish, unit uses permanent magnet to detect duct; indicates direction by two bisecting red and white hands. Four recessed lights are said to determine precise center of insert. Power is supplied by battery inside hand grip.

General Electric Co, Conduit Products Dept, Bridgeport 2, Conn.



Push-to-test pilot light

1241 • Unit is said to have regular pilot light features, plus separate circuit to test bulb. Pushing on color cap provides positive contact "feel" when unit is in test position. Pilot light is oil-tight in normal and depressed position, manufacturer claims. There are no wires; all internal connections are pressure type of silver-plated beryllium copper.

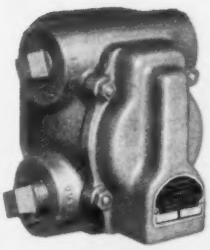
Square D Co, 4041 N Richards St Milwaukee 12, Wis.

For more details on these items, use post cards, p 191. Identify your request with item number.

Water-jet exhauster

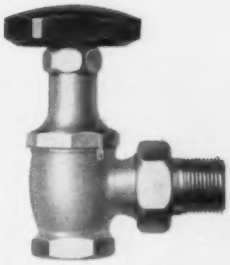
1229 • Unit is said to have reduced water requirements, making it economical for high capacities. Units are suitable for evacuating and priming a closed system before steam pressure is available at start-

STEAM UNIT HEATER VENTS



FLOAT & THERMOSTATIC TRAPS

"Y" STRAINERS



SUPPLY VALVES

HOFFMAN

Complete Line of

Steam Specialties

MAIN VENTS

TEMPERATURE REGULATORS

A COMPLETE QUALITY LINE . . .

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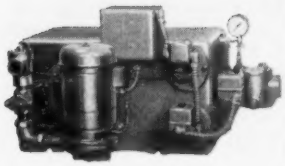
For either one-pipe or two-pipe residential or industrial systems there's a Hoffman Trap, Valve, Pump or other specialty designed to give you better control of every requirement.

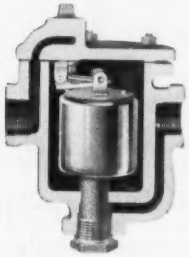
Each Hoffman product is distinguished by exclusive features that assure customer satisfaction and long, trouble-free service. This complete, tested, quality line is backed by a dependable, single source of supply and responsibility.

Write for complete catalog.

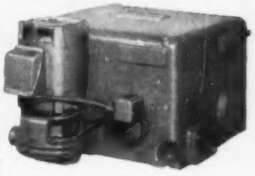


VACUUM PUMPS

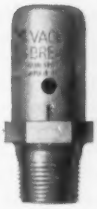
PRESSURE REDUCING VALVES



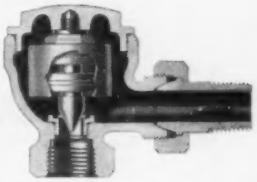
INVERTED BUCKET TRAPS



CONDENSATION PUMPS



VACUUM BREAKER



THERMOSTATIC TRAPS

HOFFMAN SPECIALTY MFG. CORP. 1700 West 10th Street, Indianapolis 7, Indiana

SOLD ONLY THROUGH LEADING WHOLESALERS OF PLUMBING AND HEATING EQUIPMENT

just say

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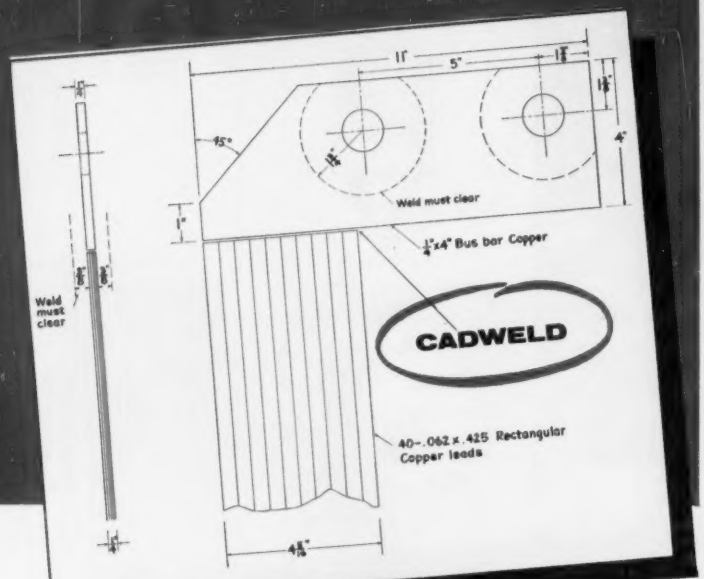

Architects, Engineers and Contractors specify "CADWELD CONNECTIONS" to insure a 100% efficient electrical system for both grounding and power requirements.

CADWELD Field Engineers are located throughout the United States and Canada.

NEW CATALOG available on letterhead request.

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Erico Products, Inc.

2070 E. 61st Place Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 3571 Dundas St., West, Toronto 9, Ontario

More EQUIPMENT NEWS

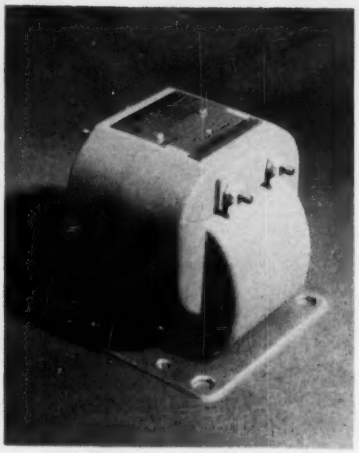
Begins on page 182

up; handling non-condensables at low absolute pressure; mixing gases with liquids.

Exhauster operates on jet principle, using jets of water from nozzles to entrain and exhaust air or gases. Water under pressure enters through inlet at top of unit, passes through nozzles, entrains air or gases through suction inlet at side.

Schutte & Koerting Co
Cornwells Hgts, Bucks Co, Pa.

For more details on these items, use post cards, p 191. Identify your request with item number.



Potential transformer

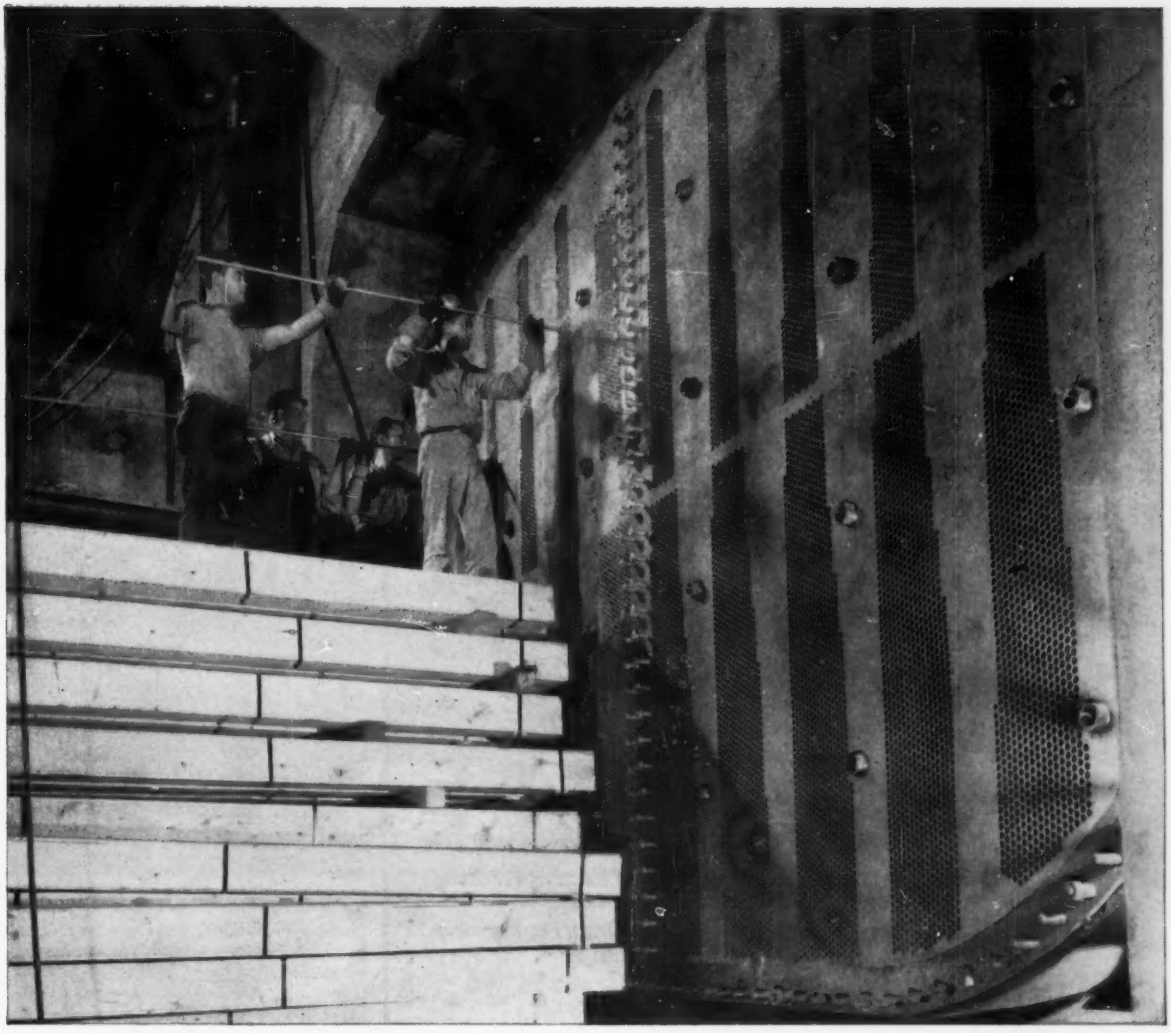
1226 • Unit is made of molded polyester, is designed for metering applications, indoor or outdoor. Voltage rating is 480-120 v, 60 cycles, according to manufacturer. Thermal capacity is 150 va; unit is said to operate within 0.3 accuracy class on most single-meter installations.

Westinghouse Electric Corp
Box 2099, Pittsburgh 30, Pa.

Heavy-duty trigger switch

1225 • Momentary-contact switch features pistol-grip handle installed at end of heavy-duty cable. Unit is said to facilitate control of electric circuits in mobile equipment and where operator needs freedom of movement for better visibility or safety.

Pistol grip is molded high-impact phenolic, switch is waterproof, trigger travel is adjustable. Unit has rating of 10 amps



Wisconsin Electric Power Company chooses ALCOA ALUMINUM heat exchanger tubes for this big surface condenser

Saves over 50% on tube costs, reports excellent service

This 105,000 sq ft surface condenser at Wisconsin Electric's No. 3 power unit, Oak Creek, Wisconsin, is the result of more than four years of tests with ALCOA® Aluminum Heat Exchanger Tubes. It is believed to be the first utility company surface condenser of its size to be fitted with aluminum tubes. Development work was handled jointly by ALCOA, Allis-Chalmers and Wisconsin Electric engineers.

The project was started in 1950 when ALCOA Aluminum Tubes were spotted in various locations and later evaluated. Initial cost savings were evident at once. Cost studies proved aluminum tubes save more than 50% in initial costs compared to admiralty.

Aluminum's superior resistance to ammonia, carbon dioxide and hydrogen sulfide is important in avoiding corrosion in the air cooler sections of the condenser. This natural corrosion resistance and the valuable dollar savings afforded by aluminum weighed heavily in the final decision to use ALCOA Aluminum Heat Exchanger Tubes. Excellent performance of the aluminum tubing in continuous service since December, 1955, has proved that decision sound. Now Wisconsin Electric plans to use ALCOA Aluminum Tubes for a second unit to be placed in operation during 1957.

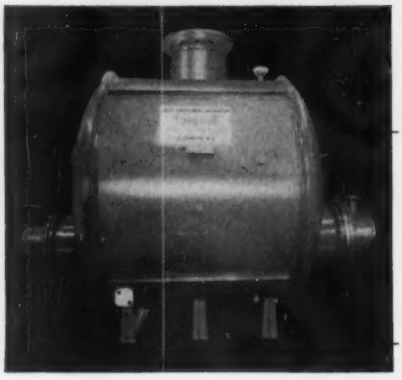
For more than 30 years, ALCOA Aluminum Tubes have been used successfully in condensers and heat exchangers. The Wisconsin Electric installation demonstrates why this general acceptance has developed—the excellent properties of aluminum alloys, ALCOA's cooperative research and development programs to establish sound applications, and industry's desire for a good product at a reasonable price.

For full information on ALCOA Aluminum Heat Exchanger Tubes, write to ALUMINUM COMPANY OF AMERICA, 888-M Alcoa Building, Pittsburgh 19, Pa.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

NEW!
"ALCOA THEATRE"
Exciting Adventure
ALTERNATE MONDAY EVENINGS

Paracoil
EVAPORATORS



Paracoil Makeup Feed Water Evaporator now serving the City of Columbia, Missouri power plant. Consulting Engineers, Lutz and May, Kansas City, Missouri. Rated at 6,000 lbs. of steam per hour at 30 psia, with carry-over not exceeding 1 PPM. Built to ASME code requirements.

creatively engineered by Davis for installation in numerous public and private power plants

Davis Engineered Features

- All tubes and rolled tube joints can be hydrostatically tested without removing tube bundle.
- Tube bundle, with outside packed floating head, has free movement to allow for expansion and contraction.
- Any tube can be replaced without disturbing adjacent tubes.
- No internal steam connection or blind gasketed joints.
- Removable tube bundle.
- Pitched tube bundle to provide for complete drainage of condensate.
- Tubes arranged on wide square pitch to facilitate mechanical cleaning.
- Straight tubes of equal length to simplify tube stocking.
- Single-pass tube bundle for maximum free flow area of steam in tubes and minimum pressure drop through tube bundle.

Paracoil Evaporator Installations include the following:

Puerto Rico Water Resources Authority
Consulting Engineers: Jackson & Moreland, Boston, Massachusetts

Borough of Wellington, Connecticut
Alabama Electric Cooperative, Inc., Andalusia, Alabama
Consulting Engineers: Burns & McDonnell, Kansas City, Missouri

Western Electric Cooperative, Inc., Andarko, Oklahoma
Consulting Engineers: Laramore & Douglass, Inc., Chicago, Illinois

City of Bryan, Texas
City of Lafayette, Louisiana
Consumer's Public Power District, Ogallala, Nebraska
Consulting Engineers: Lutz and May, Kansas City, Missouri

Davis Makes it — Better! ***Write for Bulletin 1000***

DAVIS ENGINEERING CORPORATION

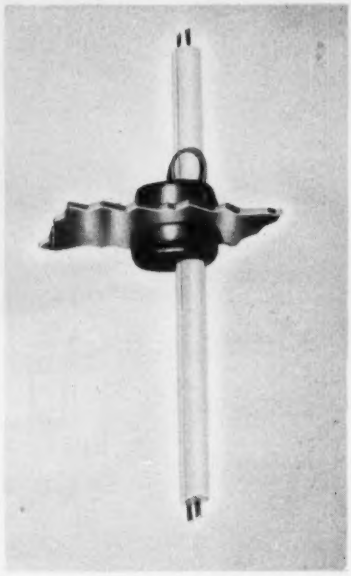
30 Rockefeller Plaza, New York 20, New York • Circle 6-5650

More EQUIPMENT NEWS

Begins on page 182

125 v ac at 0.80 power factor, manufacturer claims. Action is momentary-contact double-pole single-throw. Can be supplied with four-conductor cables of any length.

Electro Switch Corp
Weymouth 88, Mass.



Wire strain relief

1232 • Unit is designed for heavy-duty air conditioning wire, 12 and 14 gage. Nylon strain relief clamps wire and anchors it to housing, preventing wire from being pushed into moving parts or pulled off terminals. Unit completely insulates wire from raw edge of mounting hole, manufacturer states. Request further details.

Heyman Manufacturing Co
100 Michigan Ave, Kenilworth, N. J.

For more details on these items, use post cards, p 191. Identify your request with item number.

Inertia switch

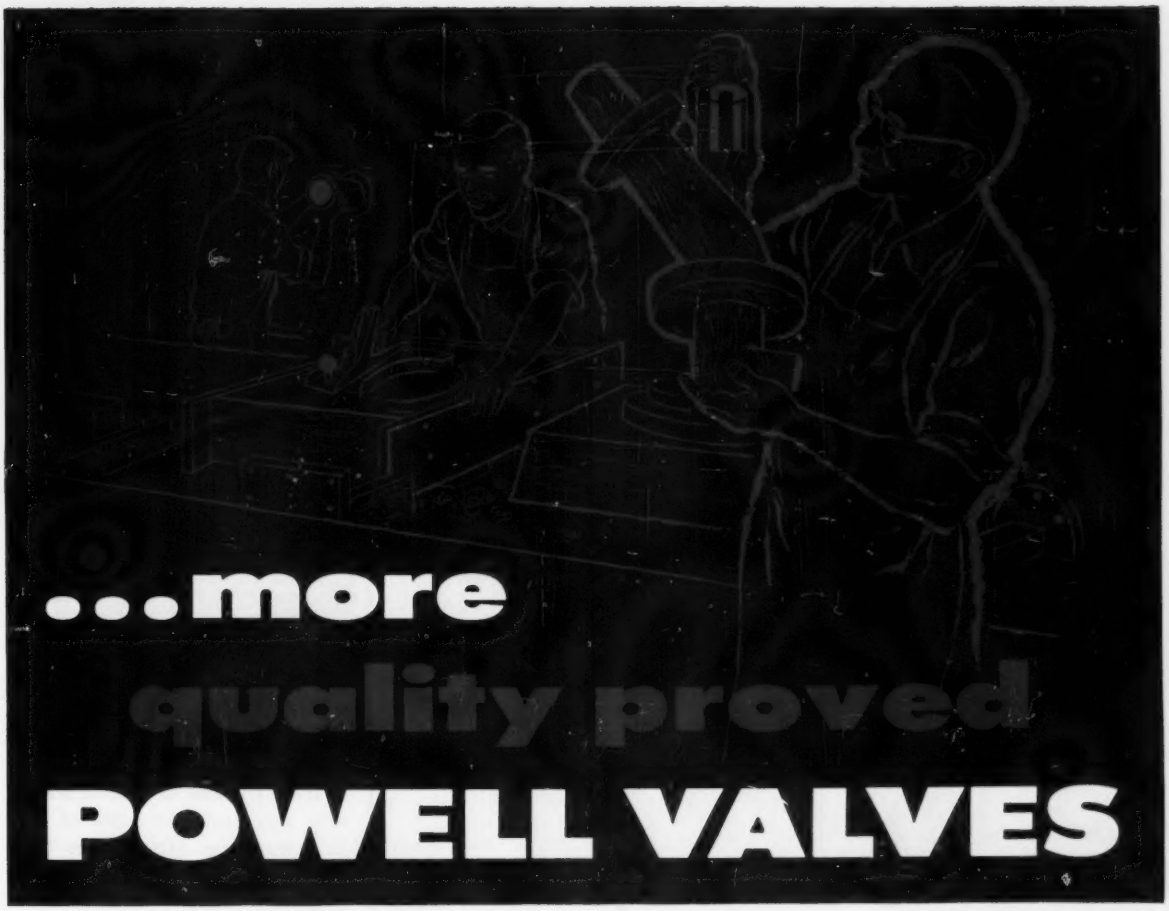
1221 • Automatic unit is said to be actuated by thrusts, impacts or excessive vibrations to provide full-time protection for unattended industrial equipment. Switch senses trouble; shuts off machine or sounds alarm.

Manual reset button or electrical reset may be used. Unit operates when subjected to thrust in horizontal direction. Contact arrangement is single-pole, normally closed. Electrical rating is 1 amp, 6 v dc.

Micro Switch Co, Freeport, Ill.

Regulator-filter-lube

1245 • Unit is said to be complete package for compressed-air operations. It regulates to desired pressure, filters water and dirt from air line, lubricates air stream. Regulator operates on balanced-piston principle. It has automatic bleed-off, per-



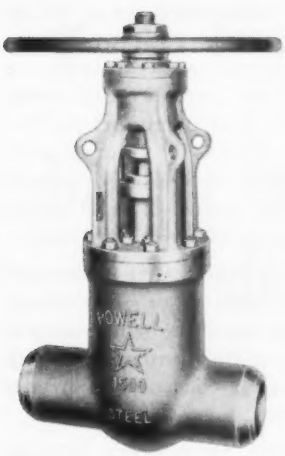


Fig. 11303—1500-Pound Cast Steel Pressure Seal Gate Valve.

Fig. 375—Bronze Gate Valve for 200 Pounds W.S.P. Union Bonnet. Inside Screw Rising Stem.

Fig. 11365—Steel Pressure Seal Horizontal Lift Check Valve for 1500 Pounds W.S.P.

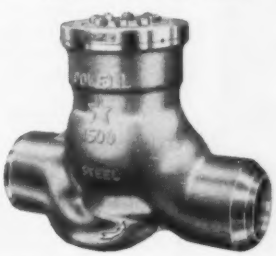
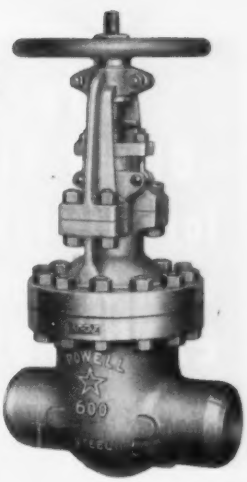


Fig. 6003-WE—Steel Gate Valve for 600 Pounds. Welding Ends. Outside Screw Rising Stem and Yoke.



for quality-crafted flow control

Ask your Powell Valve Distributor for the facts about quality-proved bronze, iron, steel and corrosion-resistant valves. Whatever your flow control problem, there's a Powell Valve to solve it.

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

STOP
DOWN TIME
for belt take-up
with stretch-free
EXTREMULTUS

EXTREMULTUS power transmission belting is not just "relatively" free of stretch. EXTREMULTUS has operated for 10 years on fixed centers without adjustment. EXTREMULTUS combines a thin elastic core of superior polymer with an unexcelled friction surface of specially chrome tanned leather. The result is service without maintenance at speeds over 10,000 feet per minute, on loads up to 6,000 horsepower, at bearing loads and belt widths a fraction of those required by other belts. Write today for full information and descriptive catalog.

EXTREMULTUS, INC.

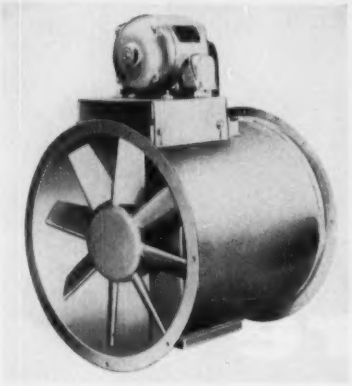
405 LEXINGTON AVE., NEW YORK, N.Y.

More EQUIPMENT NEWS

Begins on page 182

mitting sensitive pressure reduction without bleeding-down-stream line. Unit is available in ¼, ⅜, ½ and ¾-in. pipe sizes.

Perfecting Service Co
332 Atando Ave, Charlotte 6, N. C.



Belt-driven duct fan

1243 • Unit is designed to operate under corrosive atmospheres and extreme temperature ranges. Model *BD* is said to have new blade design which produces higher pressure characteristic while reducing noise to minimum. Axial airfoil blade gives complete air pattern. Unit is suitable for operating in acid fumes, explosive vapors, dust and gases; can handle temperatures up to 150 F. Details on request.

Chicago Blower Corp
9863 Pacific Ave, Franklin Park, Ill.

For more details on these items, use post cards, p 191. Identify your request with item number.

Mechanical brake motor

1244 • Unit is designed for quick releasing and fast braking. High braking torque is available. According to manufacturer, it is specially designed for precision stopping, braking overhauling loads, as a holding brake, a hoist brake and to stop motor coasting between operations.

Motors are available in polphase designs 1800, 1200 and 900 rpm and some slower and multispeed designs. According to manufacturer, the simplicity of design, elimination of coils and solenoids and long brake life greatly reduces maintenance.

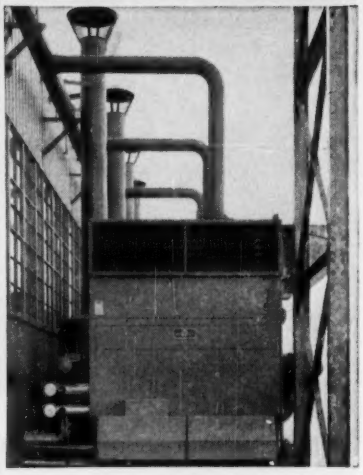
The Cleveland Electric Motor Co
5213 Chester Ave, Cleveland, Ohio

Portable hand lamp

1239 • Units are said to be explosion-proof and weather resistant. All exposed metal parts are non-sparking aluminum. Insulated handle is impact-resistant plastic. Threaded guard secures and seals globe to holder which is threaded to handle. All threaded joints are locked to prevent accidental loosening, manufacturer claims.

Pyle-National Co, 1334 N Kostner Ave
Chicago 51, Ill.

HOW
YOU SAVE...



... getting drier
Compressed Air

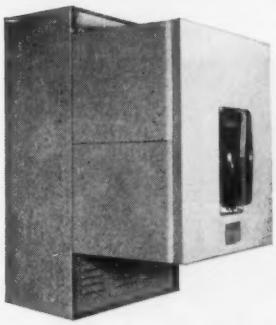
● Save the cost of cooling water and you save the price of the Niagara Aero After Cooler (for compressed air or gas) in less than two years.

Extra, for no cost, you get drier compressed gas or air for your process. You get better operation and lower costs in the use of all air-operated instruments, machines, or paint sprays. You save expense for piping, pumping, water treatment and disposal. You get the use of badly needed water elsewhere in your plant.

Niagara Aero After Cooler cools compressed air or gas (evaporatively) below the temperature of surrounding atmosphere, with no further condensation in your air lines.

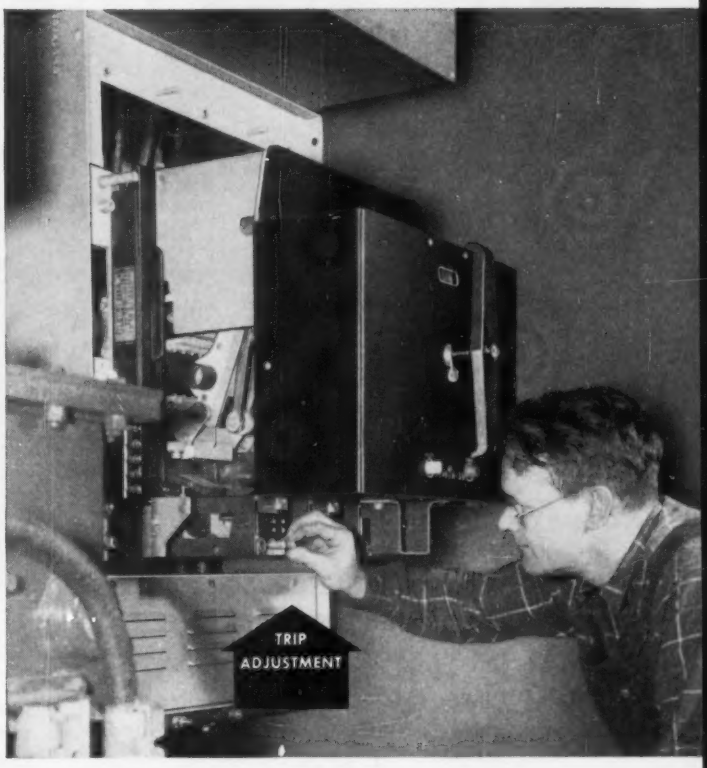
Write for complete information; ask for Bulletin No. 130, or contact nearest Niagara Engineer if you have any problem involving the industrial use of air. Address Dept. P-12.

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N.Y.
District Engineers
in Principal Cities of U.S. and Canada



ALLIS-CHALMERS
individually enclosed LOW VOLTAGE BREAKERS

If you're setting the trip device or making inspection...



Get a long look in a short time

simply removing deep front cover

The deep cover is the *not-so-deep* secret of safe, easy adjustment and inspection of Allis-Chalmers individually enclosed low voltage breakers. The entire breaker can be inspected without removing it from its position.

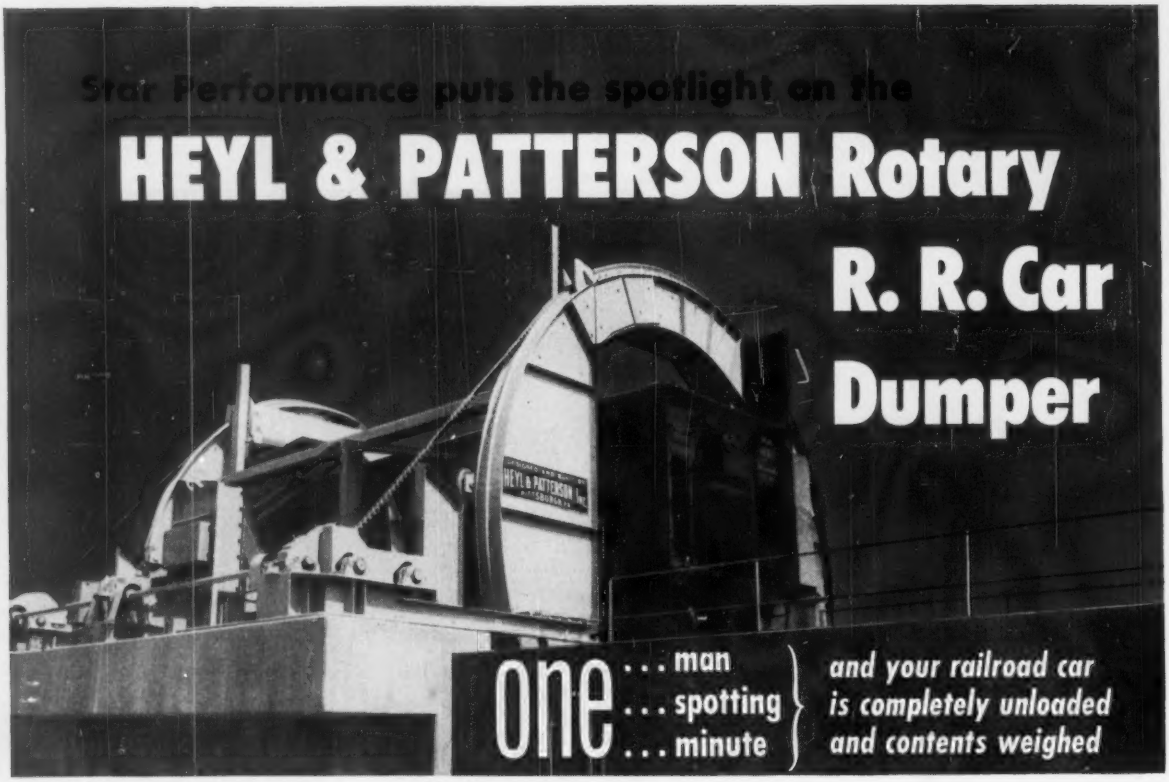
For the complete story on why Allis-Chalmers breakers are easy to use, as well as easy to install and maintain, call a local Allis-Chalmers distributor or office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

ALLIS-CHALMERS

A-5564

Star Performance puts the spotlight on the

HEYL & PATTERSON Rotary R. R. Car Dumper



View of the Dumper at Buffington, Indiana Plant, Universal Atlas Cement Company.

- **Dumper is designed to rotate, dump and return to initial position in just one minute.**
- **Rotation can be stopped instantly at any position with car and platen firmly held in place.**
- **External and movable counterweights have been eliminated.**
- **Platen-mounted electronic scale is simple, accurate and economical.**
- **Car retarder on dumper permits economical and safe car spotting by dumper operator.**

To achieve the most economical car weighing and dumping operation, the H & P Rotary Car Dumper can be equipped with a car retarder or an electronic scale, or both. This H & P electronic scale platen (Patent Pending) uses load cells which permit instant weighing and light-weighing of car in compliance with National Bureau of Standards acceptance tolerance, and printing of weigh tickets. Exceptional accuracy and trouble-free operation are assured due to absence of wearing parts.

By all standards, the H & P Rotary Dumper is the most efficient method of unloading large quantities of bulk materials from open-top railroad cars.

Even if you receive only a relatively small number of cars per day, may we suggest that you investigate the economics of the H & P Rotary Railroad Car Dumper.

MAIL COUPON TODAY FOR NEW DUMPER BROCHURE 957

HEYL & PATTERSON, INC., 55 Fort Pitt Blvd., Pittsburgh 22, Pa.
Please send me my copy of the H & P Dumper Brochure 957.

Name _____ Title _____

Company _____

Address _____

City and State _____

70 YEARS OF SERVICE

Heyl & Patterson INC.

55 FORT PITT BLVD. • PITTSBURGH 22, PA.
PHONE COurt 1-0757

MARMADUKE

Continued from page 170

me what I wanted. After we'd chewed the fat awhile, he told me he'd been operating the plant during the canning season for over a dozen years. Far as he knew, there weren't any jobs. He told me migrant canning workers came through daily, who were willing to work for almost nothing. That's how bad things were in '33.

"While I was talking with the operator, two men came into the boiler house. They were arguing and waving their arms at each other.

" 'What the hell ya take me for, a jackass?', yelled the big guy with his shirt sleeves rolled up. 'You get me to throw out those old steam reciprocating pumps for your damn fancy centrifugal junk. And what happens? Here it's the peak canning season and I got wagon loads of ripe tomatoes to can. But can I can them? Hell no! And what do you do? Nothing—just give me a song and dance to spend more money. You say your pumps are OK. What in hell am I supposed to do—swallow that stuff and go broke? And you've got nerve enough to expect me to pay for those pumps, too?'

"I listened for awhile. The old operator had scooted behind his boilers like a scared rabbit. The sales engineer just stood there taking most of the abuse, getting red as the boss's tomatoes. Steam pressure was at the popping point.

" 'Excuse me, gentlemen,' I cut in, 'but I'm a marine engineer looking for a job. Most marine oilers could straighten out a two-by-four plant like this without thinking twice. My help will hardly cost you a penny—all I want is enough chow to iron the wrinkles out of my belly and a few dollars to get me to the Great Lakes.'

"Both men stopped suddenly — glared at me. Finally the sales engineer said, 'OK, stranger, you got yourself a job. Get those boilers up to their steaming capacity so these tomatoes are canned on time and you'll make yourself fifty bucks.'

" 'If you do that,' added the owner, 'I'll throw in another fifty and give you a job running this plant until the season is over in three weeks.'

"I asked the sales engineer what all the shouting was all about. Here is his story.

"The plant was working at peak capacity, twenty-four hours a day, seven days a week. They had to can those tomatoes before they spoiled. But the boilers were a serious bottleneck since the new feed pumps had been installed. Big trouble was from very wet steam

(Continued on page 208)

RAMBLINGS ON INSTRUMENTATION

Surprise Package

A friend of ours recently was griping about some troubles he was having with the controls in his steam plant. He had a packaged boiler which had been furnished complete with burner, the burner having been furnished with Brand B type control (to coin a phrase, "in one big ball of wax").

All was peachy until it turned out that the control wasn't doing the required job. When the boiler people were contacted, our friend was told to check with the burner people who sent him to the control manufacturers who said, "Sorry, no service available."

When he asked us for a comment, we told him that we liked to suggest that the burner be left to the burner manufacturer and the boiler to the boiler manufacturer.

But when it comes to controls, we feel that these should be left to control manufacturers (people like us) who not only engineer the specific job better, but can also service it if it is required. Buying your controls this way pinpoints responsibility, assures a fully engineered job and prevents the customer from having to become a "do-it-yourself" engineer.

Guide Right!

For four months we've taken you on a Ramblings Safari into the intricacies of boiler plant control systems. As threatened in our last installment, this month we'd like to talk about combustion guides.

If you've been paying attention, you know by now that a combustion control system is designed to maintain the highest combustion efficiency possible. The combustion guide serves as a check on the efficiency of the system.

These combustion guides are pretty useful gadgets. Specifically they:

1. aid in control calibration
2. give visual evidence of combustion efficiency
3. give you a historic record of combustion conditions
4. aid in fuel switch over

Finally, if you pick an electronic gas analyzer as your guide, it serves as a dandy lunch warmer.

There are four different instruments which will do the job and Hays makes them all. These are:

1. The boiler efficiency meter, a recorder where the air flow and steam flow pens are kept together by changing the fuel-air ratio of the control system. This is a *quantitative* measurement where actual fuel and air are metered.
2. The combustion meter, an automatic orsat analyzing the combustion gases *qualitatively* as an indication of fuel-air ratio. This low-priced, fully automatic, mechanically operated instrument provides a record of CO_2 in combustion gases.

Ain't science wonderful! This O_2 meter proves everything's Jim Dandy!

3. The Condu-Therm CO_2 Analyzer, a fully electronic thermal conductivity type analyzer having no analyzer moving parts, requiring no chemicals. It provides a continuous record of CO_2 in the flue gas.
4. Magno-Therm O_2 Analyzer, a magnetic type unit which analyzes flue gas for O_2 as a function of excess air. It is not affected by variations in fuel composition, % of O_2 remaining constant at the same excess air, despite variations in fuel.

We'll cover these a little more thoroughly in the next few installments. If you can't wait for more details, however, just send us your name and we'll mail you an 8-page booklet in two beautiful colors, slyly canted toward Hays equipment.

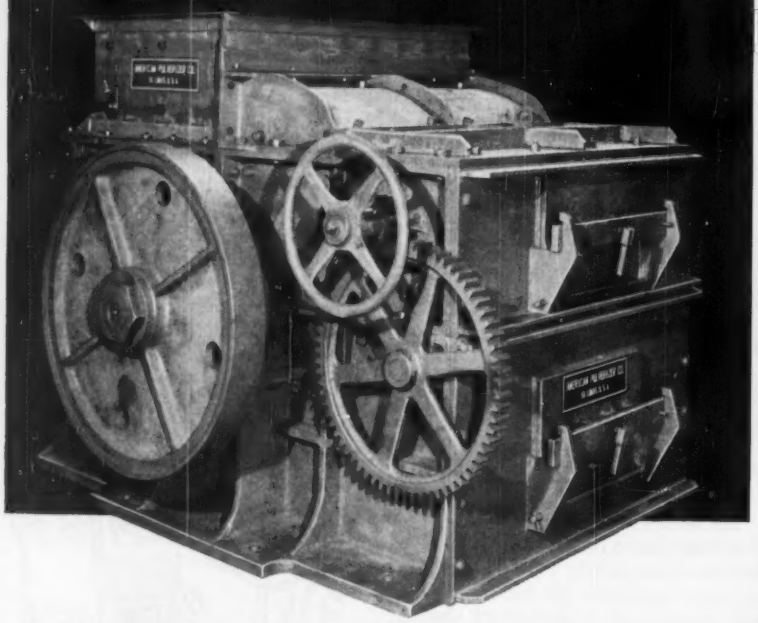
See you next month.

Phil Sprague Jr.

President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

American Coal Crushers are RUGGED!



Soundly engineered and constructed to give you many years of high volume crushing at low operating costs.

1. Oversize bearings.
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6. More efficient crushing design which permits slower operating speeds and less power consumption per ton of coal crushed.
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8. Maximum flexibility of rolling ring rotor prevents injury from tramp iron.
9. Full width screening area gives faster discharge of reduced product.

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1349 MACKLIND AVE. SAINT LOUIS 10, MISSOURI

MARMADUKE

Continued from page 207

and a wide variation in steam pressure. And during the widest pressure swings, the boilers were using up more natural gas than usual.

"All this was puzzling to the sales engineer, the operator and the owner. They just didn't know where to turn.

"'OK,' I told them. 'You guys shove off and let me look around. When I'm ready I'll drop into the office and tell you what I've found.'

"They cleared out and I spent twenty minutes looking around; got so interested I forgot I had already missed three meals. First I checked the boilers' operation, then the auxiliaries. I could see the old boilers had been purchased secondhand. They had no superheaters, but seemed to be in fair shape.

"For a few minutes I watched the steam pressure and water level while keeping an eye on how the feed pumps were operating. It wasn't long before I learned that those pumps operated less than half the time. When a pump started, water level in its boiler stayed constant for several minutes or even dropped slightly. Then all of a sudden the water level rose rapidly until the pump shut off. But water level in the gage continued to rise—at times to near the top of the gage glass. Then level started falling slowly. When the level dropped far enough, the float-actuated mercury switch again started to pump and the cycle repeated.

"It wasn't hard to figure that, because of the small water-storage capacity in those boilers to heat incoming water, the feed pumps would start to fill the boilers with cold water. Since water entered the boiler at a high rate, the cold water reduced steaming rate and caused a further reduction in water level.

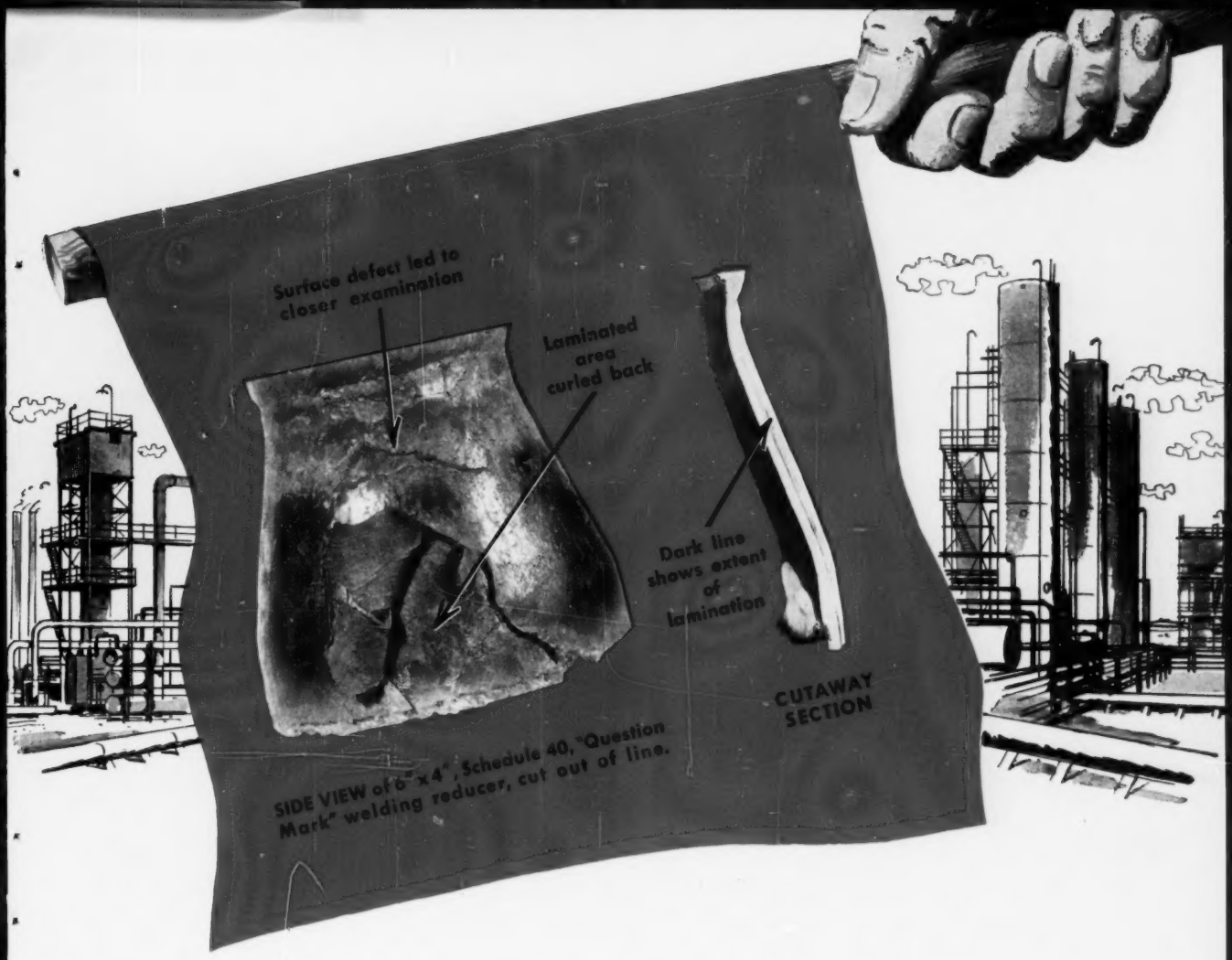
"When level was finally raised to point of cutoff, the boiler was full of cold water and couldn't generate steam fast enough. But when the water finally did warm up and the boiler started steaming as it should, the water level rose. Then carryover from boiler to process caused the steam to be very wet. And that caused plenty of trouble in processing the tomatoes because the kettles weren't hot enough.

"I also reasoned that there was a sharp reduction in steam pressure when two of the three boilers swung. Then more slugs of wet steam caused more trouble throughout the cannery.

"Once I figured what was happening, I came up with a solution—fast. I headed for the office.

"'Don't tell me you've got an answer

(*Continued on page* 212)


Surface defect led to closer examination
Laminated area curled back
Dark line shows extent of lamination
CUTAWAY SECTION
SIDE VIEW of 6" x 4", Schedule 40, "Question Mark" welding reducer, cut out of line.

Watch out for the after-costs of *Question Mark* fittings!

Unknown fittings may look like a bargain on the price tag, but watch out for the consequences!

Surface defects led to the above "Question Mark" fitting being cut from the piping. Further examination showed the steel inside was laminated. Pieces cut out literally fell apart. Here was an open invitation to serious trouble . . . lost production, wasted dollars and possible human casualties.

This is another example of a dangerous situation posed by unknown fittings of questionable quality . . . a serious threat to the safety and economy of well-engineered piping.

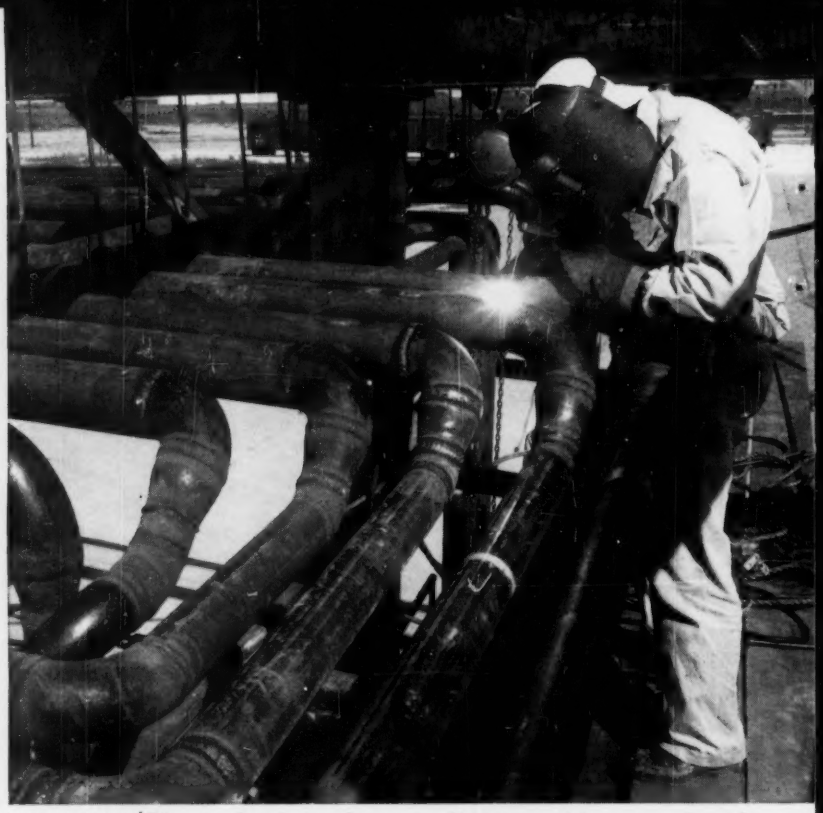
You can avoid these risks by specifying KNOWN fittings!

DANGER! *Your first warning of Question Mark fittings is their lack of complete, permanent identification of manufacturer, wall thickness, weight, material . . . as required by A.S.A. code.*

A message in the interests of top quality piping
. . . by Tube Turns, Louisville, Kentucky

YOUR SAFEGUARD

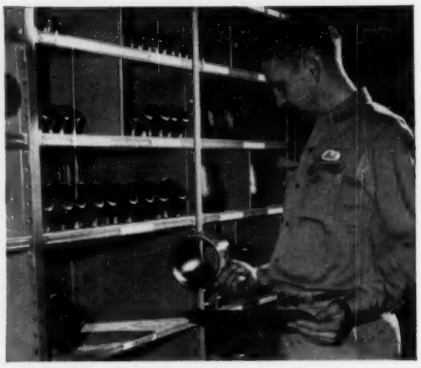
Safeguard your piping investment with known fittings!



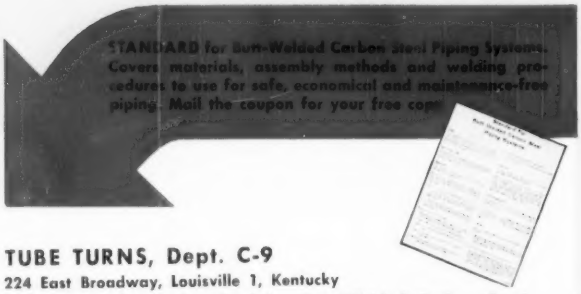
TOP QUALITY! *Directional and size changes in this process piping are made with TUBE-TURN Welding Elbows and Reducers . . . recognized for their unsurpassed uniformity and quality.*

The cost of fittings is a small fraction of the total cost of a piping system. To buy "cheap" fittings and run the risk of impairing the performance of your entire system can, therefore, be "penny wise and pound foolish."

When you specify and buy TUBE-TURN* products, you know your investment is safeguarded by unsurpassed quality of fittings and flanges. They meet all American Standard and Safety Code requirements. Each product is permanently marked with complete size and material designation.



COMPLETE LINE! *Your nearby Tube Turns' Distributor gives you prompt delivery from the complete line of more than 12,000 Tube Turns' stocked items. Photo courtesy The Ross-Willoughby Co., Columbus, Ohio.*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Cincinnati Gas & Electric
Columbus & Southern Ohio Elec. Co.
Omaha Public Power District
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Dayton Power & Light Co.
Duke Power Co.
East Kentucky Rural Elec. Cooperative
Florida Power Corp.
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Northern States Power Co.
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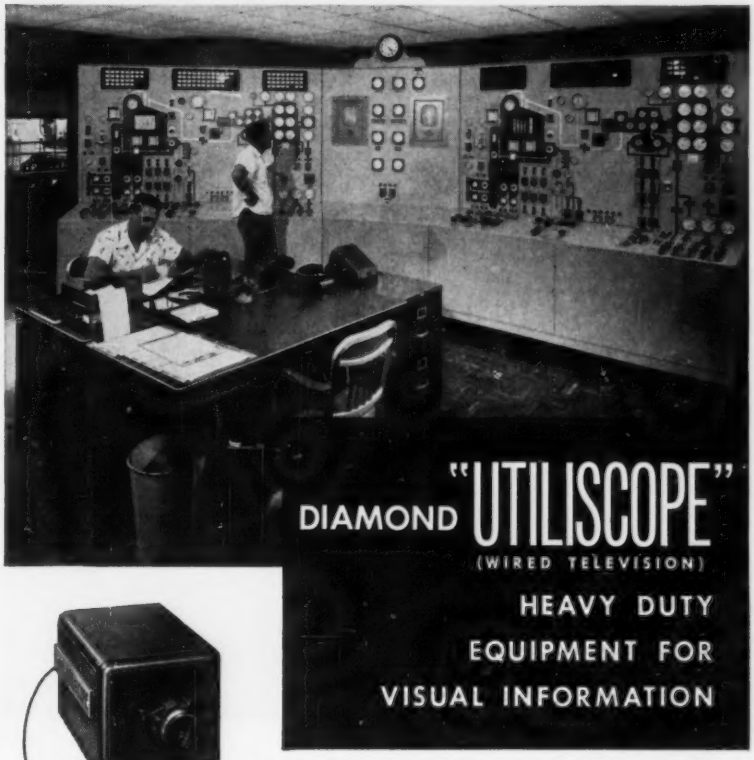
Toledo Edison Co.
Utah Power & Light Co.
Virginia Electric & Power Co.
Western Mass. Elec. Company
West Penn Power Co.
Wisconsin Public Service Corp.



"UTILISCOPE" CAMERA

"UTILISCOPE" RECEIVER

The Diamond "Utiliscope" makes possible the ultimate in automation for power plant control. It enables the operator to see clearly anything that requires visual check. He no longer need depend upon indirect interpretations to know what is happening outside his range of vision.

The operator in the above photograph is watching the ITV image of the water level in two boilers . . . transmitted by "Utiliscope" cameras focused on Diamond Bi-Color water gauges. The water levels are easily and unmistakably read on the viewing screens. There can be no error . . . the level is shown correctly or there is no picture.

The Diamond "Utiliscope" is heavy duty equipment for power plant application. Other power plant uses are: watching flame conditions in boiler furnances, watching smoke emission from stacks, and watching remote entrances for intruders. Have you explored the "Utiliscope's" resources for saving money and improving operation? Use the coupon below for further information.

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SWECO introduces a complete new line of steam jet ejectors, available in single and multiple stages and in a wide range of sizes and materials. Entirely new designs incorporate the most recent developments in the field—to meet the vacuum requirements of the power and process industries flexibly and efficiently.

Ejectors, the most widely used vacuum-producing devices, are particularly applicable where condensable vapors or corrosive substances must be condensed. SWECO's improved construction utilizes corrosion-resistant materials to protect the unit while in operation and to minimize rusting during shut-down. The units are generously designed, easy to service, with ample test connections for quick performance checks in the field.

SWECO Steam Jet Ejectors are available from 1" to 8" and larger, and from 1 to 6 stages. For extra flexibility, any number of units may be used in parallel. Various combinations of inter-condensers and after-condensers can be provided for individual requirements.

A new 8-page bulletin describes and illustrates design, construction, sizes, combinations and uses of SWECO Steam Jet Ejectors. It also includes a set of valuable Dalton's Law charts with instructions to determine the relationship between percent air in various air-water vapor mixtures vs temperature of the mixtures for various pressures. Write for your copy. It's Bulletin M-4-393.

See SWECO *equipment at the 26th Exposition of Chemical Industries, New York Coliseum, December 2-6, Booth 1307.*

SWECO

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ENGINEERS AND CONSTRUCTORS...MANUFACTURERS

MARMADUKE

Continued from page 208

already,' said the owner, giving me a fishy look.

"'Yes and no,' I answered, 'but at least I've found the trouble.'

"'What is it?', asked the salesman. 'I hope it's not the pumps' fault.'

"I outlined my theory while they listened carefully, hanging onto every word I had to say.

"'OK, OK,' said the owner finally, raising his voice. 'But how do I can my tomatoes?'

"'Let's go into the boiler room and see,' I said. So the three of us walked back to the boiler room.

"'I believe I can straighten her out without taking anything apart or making any changes,' I told the two men. 'If it's OK with the pump salesman here, I'll just throttle down on the discharge valve of each feed pump and feed water at a lower rate, but for a longer period of time. That should stop the cycling.'

"'You mean to tell me you can lick this problem by just choking down on the discharge valves?' asked the owner, scratching his head.

"'That's right,' I answered, 'but I want the pump man here to give me the green light.'

"'Go right ahead,' advised the salesman. 'You can't hurt those pumps by throttling. And if you do, I'll take the blame.'

"After experimenting a few minutes by closing in on each discharge valve, I finally got the pumps set so all three boilers held the water level. Steam gage froze at 200 psi and the cannery got working at top capacity because the steam was dry.

"'You saved the day for me—and the season!' said the owner, slapping me on the back. He wrote out a check and flipped it my way. 'And now I'll be able to collect for these pumps!' chimed in the salesman, handing me five ten-dollar bills.

"'Just show me the way to the nearest restaurant,' I said, pocketing the dough and tightening my belt another notch.

"'Right across the road,' said the owner. 'Tell Eddie to give you the biggest order of ham and eggs he ever dished out—I'm paying for it. And don't forget to come back here; I can use an operator who *is* an operator.'

—*SME*

BOILERS DO BELCH

I enjoyed Marmy's *Belching Boiler* for I have experienced the same trouble. Fact is that gas explosions are often caused from blowing gas back into the furnace when blowing boiler tubes.

W R PENDER, *St. Petersburg, Fla.*

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SERIES 1522, 1531 AND 1510
CENTRIFUGAL PUMPS
AVAILABLE FROM STOCK
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VERTICAL SPLIT-CASE DESIGN
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SEND THE COUPON TODAY FOR THIS CATALOG OF

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Why take a production loss because of a pump breakdown? B&G *maintains a factory stock of the most commonly used sizes of centrifugal pumps for immediate delivery!* Base-mounted and integral-motor pumps as listed in B&G Stock Pump Catalog are available in capacities to 325 GPM, heads to 140 ft.

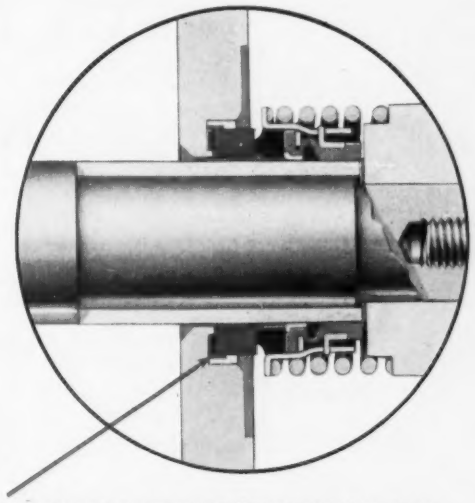
Your local distributor or B&G Representative will be glad to assist in selecting the proper pump for your needs. Or, write, wire or phone the Bell & Gossett factory at Morton Grove, Illinois. In any case, you'll get fast action.

B&G SERIES 1522, 1531 AND 1510 STOCK PUMPS ARE DISTINGUISHED BY VERTICAL SPLIT-CASE DESIGN...NON-OVERLOADING MOTORS... BRONZE FITTED CONSTRUCTION . . . LEAK-PROOF "REMITE" MECHANICAL SEAL

Why B&G Centrifugal Pumps give years of trouble-free performance is evident from their design features.

Vertical split-case construction permits removal of the bearing bracket without disconnecting pipe lines or motor leads. Solid cast iron volute—with support feet in larger sizes—prevents transmission of piping strains.

The shafts are made of special alloy steel, super-finished and oversized to keep deflection at a minimum. In Series 1522 and 1510 Pumps oil lubrication affords continuous protection to the heavy duty bearings. Leak-proof operation is assured by the "Remite"* Mechanical Seal—an exclusive B&G development.



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Each hoist weighs 93,000 lbs., shipped completely attached with all electric motors, controls, limit switches, wired ready for operation when installed at Long Sault Dam . . . its overall length is 57 feet, 8½ feet wide, 12½ feet high . . . with a lifting capacity of 175 tons, and will raise and lower the gates in the dam at a speed of 1 foot per minute.

This is one type of Gate Hoist designed and manufactured, backed by nearly 75 years experience . . . in a wide range of capacities from this range capacity to less than one ton.

Write for complete information on MURCO Gate Hoists and engineering recommendations to meet your specific power dam requirements.

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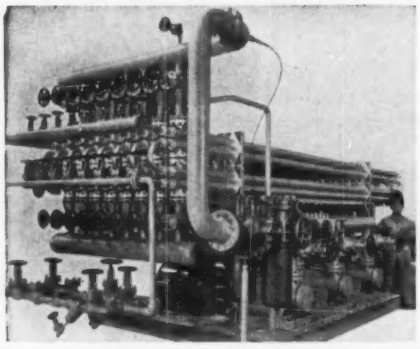

Photo shows one of two, High-Pressure (1000 PSIG) Units being furnished for a Public Utility in the Southwest . . . 3 electrically-driven screw pumps and multiple arrangement of Griscom-Russell Twin G-Fin Heaters handle 230 GPM of heavy fuel oil. Equipped with: Strainers, Temperature and Pressure Controls.

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For more than a half-century Lockett has been supplying standard and custom-built Fuel Oil Pumping and Heating Sets, for mechanical and steam atomizing oil burners. Various types of Pumps are available: Turbine or Motor-Driven Rotary Pumps, Electric-driven Rotary Pumps, and Duplex Steam Pumps, in any combination. Units can be furnished for any capacity or pressure desired; complete with Strainers, Pressure and Temperature Controls, and Instruments. Engineered to your requirements. Completely assembled and shop-tested. Inquiries are invited. *Descriptive Bulletins* sent on request.

A. M. LOCKETT & COMPANY, LTD.
NEW ORLEANS • HOUSTON • DALLAS

SOOT BLOWING

Continued from page 109

ing blower manufacturers and utility people are chiefly (1) valves and packing (2) wallboxes and seals (3) drives and (4) nozzles. For years, accent has been on development of a reliable, trouble-free blowing medium valve. With steam, valves endure severe service conditions. Frequent openings and closings and steam-condensate mixtures cause rapid erosion of valve parts. The blower mechanism's limited operating force (motor-operated valve cost not felt to be justified by most users) necessitates a design which can't be as tight as a conventional valve. Leaks result, both across the seat and through the packing.

Lance-tube packing is another tough nut to crack due to the large diameters, long travel, and limited drive forces involved. Packing manufacturers can't prescribe a material today which'll completely satisfy these conditions, especially for steam blowing.

On steam installations, dripping water and icicles in cold weather usually accompany valve and packing leakage. These visible annoyances (dangers, too, where icicles may hang 7 or 8 stories above an operating-level platform) accentuate the problem for operating personnel. Drip pans are seen in some plants where the superintendent is especially realistic. Steam-piping system modification helps to provide better drainage and eliminates some of the condensate, but it's difficult to design packing which'll be effective for both water and steam.

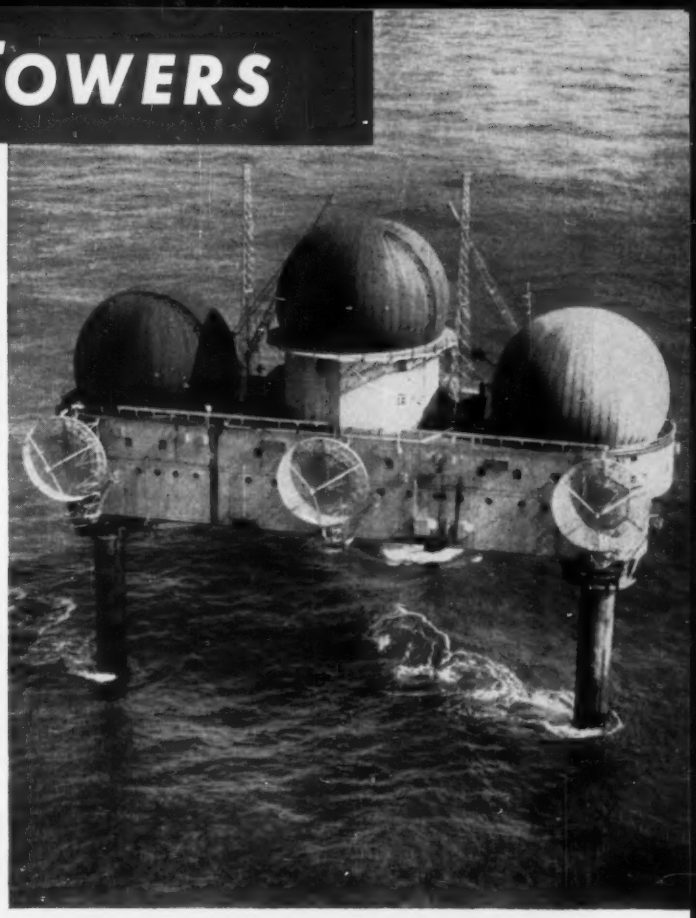
Increasing consideration being given to air blowing is partly due to these difficulties. Valve and packing improvement will have a significant effect on future trends to steam or air.

Wall sleeves used for blower lance entrance through the boiler wall are exposed to high heat and the intermittent quenching action of condensate from valve leakage. In the furnace hot zones the sleeves frequently "burn out" if not properly designed or made of a high-temperature alloy to withstand such conditions.

Wall seals have given considerable trouble on some pressurized-furnace boilers. These seals must prevent furnace-gas escape, yet provide for blower lance entrance. The seal itself is exposed to flyash, water and heat. All present seal designs are two-way leakage type, using forced-draft air as a sealing medium. Allowing forced-draft air to leak into the boiler and out to the ambient air prevents furnace-gas escape.

Some delicate, close fitting seals designed around this principle but with-

ON TEXAS TOWERS



Wallace Process Piping Co., Inc.

Used

MIDWEST

WELDING FITTINGS

Among the unique installations for preservation of peace are the early warning radar "Texas Towers" off the Atlantic Coast. These artificial islands stilted to the ocean floor keep watch by radar. As is true of many defense projects, Midwest Welding Fittings played a significant part on Texas Towers.

Midwest Welding Fittings are found on unusual and in critical as well as routine jobs because of exceptional quality maintained by rigid standards of manufacture. Quality control is always above and beyond code requirements.

Whatever the piping job, you will find it to your advantage to use Midwest Welding Fittings. The many benefits you get by specifying "Midwest" are shown in Catalog 54. Ask your distributor or write us for a copy.

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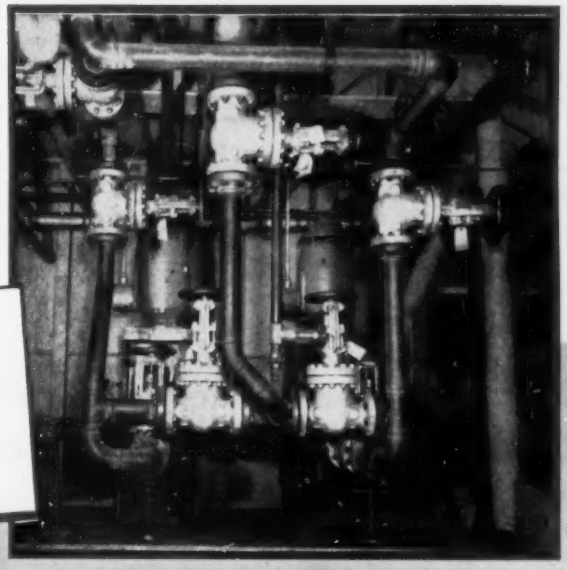
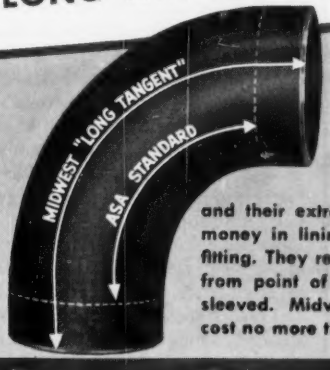


MONEY SAVED With MIDWEST "LONG TANGENT" ELBOWS



Here are the important advantages of Midwest "Long Tangents": They save pipe. They often eliminate short nipples and their extra welds. They save time and money in lining up and clamping pipe and fitting. They remove the circumferential weld from point of maximum stress and can be sleeved. Midwest "Long Tangent" Elbows cost no more than other elbows.

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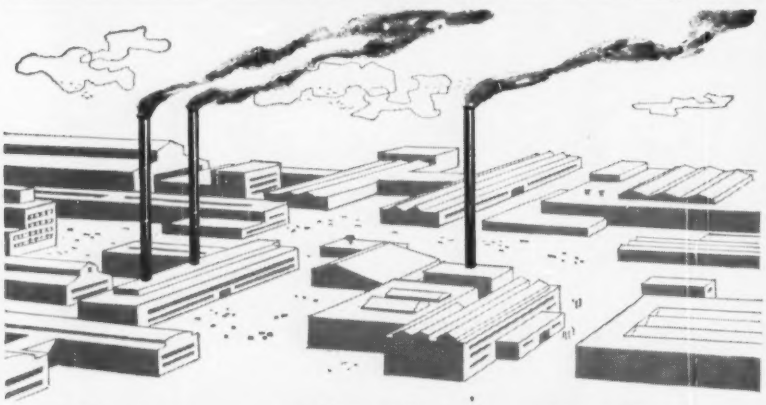

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SOOT BLOWING

Continued from page 214

out full appreciation of the severe operating conditions have a tendency to wear, jam, or leak gas. Lances in especially hot furnace locations may build up a dense fireside scale deposit unevenly along the lance's length, making the seal's job even more difficult.

With pressurized furnaces, means must be provided to remove the seal for maintenance or lance replacement. Sometimes this is incorporated, with the boiler's other openings, into suction-firing provision. Here, induced-draft fans are installed to permit part or full load operation while work's being done on the openings.

Another scheme provides a device to act as a "shut-off valve" at each opening during maintenance or repair. Aspirator use is common for this purpose, though the small air nozzles have a tendency to plug with flyash during long exposure periods between use. In other cases, hand-operated slide gates have been used with success.

Power-driven blowers predominate in today's central stations, while small installations or little-used locations generally have hand-operated chain drives. For the power drives, electric motors usually get the nod over air motors because of the latter's higher maintenance needs. Though the air drive's first cost is considerably lower than the electric's, it's not as easily adapted to centralized sequential control monitoring and interlocking function.

The merits of single versus double-motor drive on blowers is a subject of continuing debate among competing manufacturers. Both systems give generally adequate cleaning results. Double-motor drive offers more flexibility in difficult locations, and a somewhat faster wall blower; however, its cost is naturally higher than for a single-motor drive.

Better blowing medium utilization is the target of many blower manufacturers' research programs. The necessarily large amount of blowing makes slight losses or inefficiencies quite important. All manufacturers use the venturi nozzle and current designs include round and square nozzles, short and long nozzles and various other shapes and sizes. The object of course, is to get the steam or air where it will do the most good and have the most "punch" for the available energy content of the supply.

Reliable nozzle performance data under field conditions is very difficult to accumulate. The character of slag and ash deposits in a boiler is constantly changing, and the utility in-

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For OIC forged steel valve specification literature, write for Forms No. 195 and 195-R.

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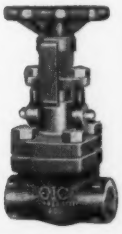

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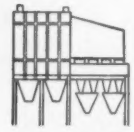

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SOOT BLOWING

Continued from page 216

volved isn't likely to be in a position to risk losing a unit just to find out the point at which a soot blower will no longer clean. Nozzle-efficiency experiments and other refinements are usually postponed objectives, although recognized as desirable.

Tube cutting by soot blowers is another headache in some boilers. Cutting results from abrasive action of flyash or slag against the tube surfaces and, if permitted to go far enough, can mean a burst tube and a boiler outage for repair. Definite erosion of tubes adjacent to wall blowers or at the furnace corners is common and is caused by entrained slag and ash in the blower jet. Severity of cutting is a function of the space relationship of tubes and jet, blowing pressure, and material and wall thickness of the tube itself. Some difficulties with superheater tube quenching and erosion are believed to be due to the proximity of retractable blowers.

Wall-blower location relative to furnace corners, nozzle-position setting and blowing pressures gets close attention today. During boiler outage, inspection of all tubes adjacent to blowers can't be recommended too strongly.

As better soot blowers are developed to meet the demand for more reliable operation under severe conditions, equipment and installation costs rise. One eastern power company spent approximately $1 million on a soot-blowing system for a new 350-mw station. This is roughly 2% of total plant cost, and 5% of the boiler cost. The blowers themselves cost about one-third of the $1 million, the rest went for facilities for blowing medium supply (steam), wiring and controls, extra platforms used exclusively for blower access, equipment installation and initial start-up modifications to the equipment. This didn't include any additions, or blower-location changes, or basic redesign. Total cost added up to about $3.00 per kw, which illustrates that a lot of money is being spent for better soot-blower installations.

Soot-blower improvement obviously is desirable. Big question is: "how much better?" What should be the manufacturers' ultimate goal for quality? Better design usually means higher initial cost; it should also mean less maintenance. Balance point in this tug-of-war is hard to establish. Manufacturers frequently run up against consderable variation in feeling among the utilities themselves. Some, by evaluating maintenance costs carefully, justify a higher equipment price tag. Some buy largely on price and rely

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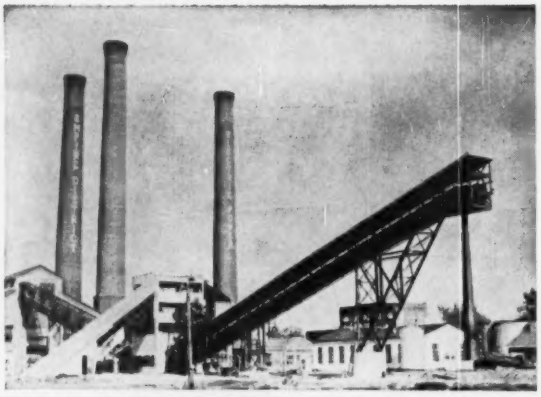

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SOOT BLOWING

Continued from page 218

on pressure on the manufacturer to produce improvements. The manufacturers' complaint is that they don't know in which direction to push their efforts.

End cost of almost any manufactured product is a reflection of the customers' desire for more or less quality. In the long run, the user gets the bill for every nut and bolt that goes into a product, plus a more-or-less fixed profit percentage for the manufacturer. In general, the manufacturer designs and builds his product to suit the market's expressed desires, and then charges an appropriate price for the resulting equipment. Clever design and efficient production methods can give a competitive advantage to one manufacturer over another but, by and large, the whole industry responds to trends in customer quality preference.

Power-plant equipment manufacturers find this preference factor to be especially compelling. As in most capital-goods industries, the market is limited and very specialized. Manufacturers must be quick to respond to changes in the utilities' points of view on such subjects as reliability, performance, maintenance, new applications, etc. At the same time, the utilities must recognize the justification for the price changes that usually result. It all boils down to the fact that utility operating and engineering people's careful judgment is very important in setting the pace for future soot-blower design and quality.

COMPRESSED AIR

Continued from page 115

in the numerator is a difference of two volumes. But in either case this volume represents the volume of air drawn into the cylinder for compression during one cycle.

Varying air output. An air compressor produces a given mass of compressed air per cycle. To vary the rate of air output we could vary the speed of the compressor to vary the number of cycles per minute.

Another method would be to vary the volumetric displacement of the piston from V_D to V_D' as shown in Fig. 6*b*. This varies the amount of air drawn in per cycle from ΔV to $\Delta V'$ and the amount of work input from W to W'. It also changes the clearance volume from V_c to V_c'.

Neither of the two methods proves practical for air flow control. The method generally used varies the

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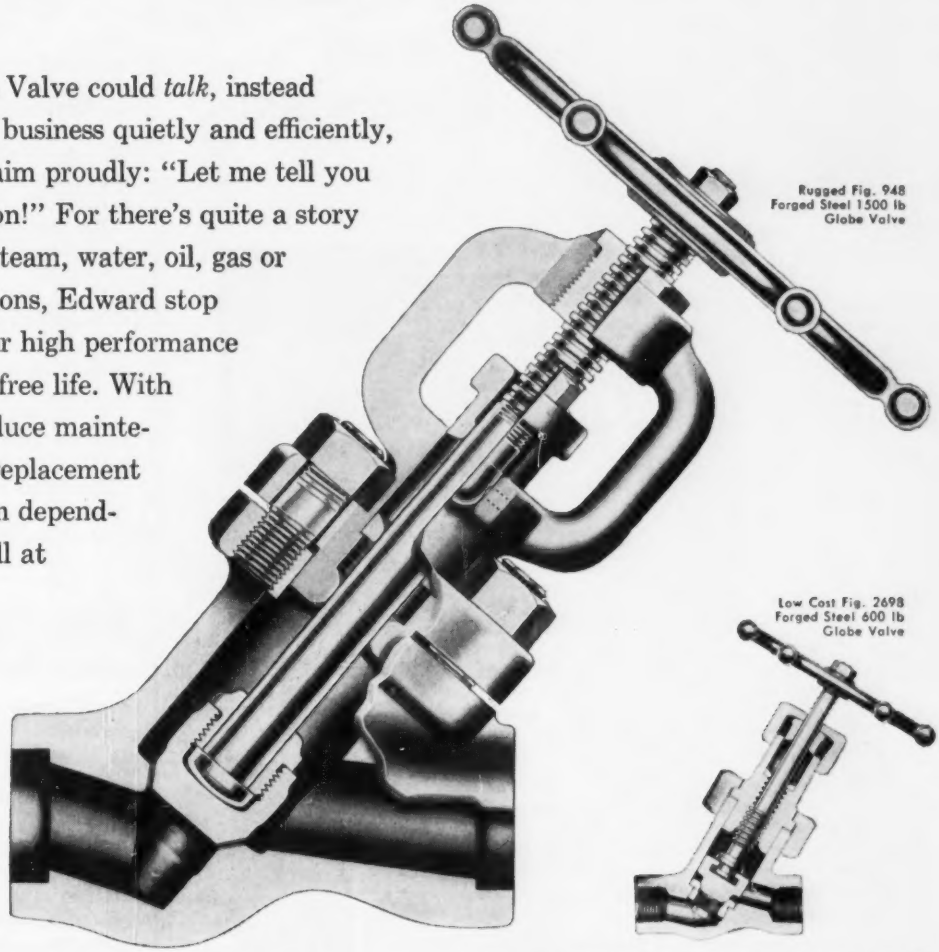

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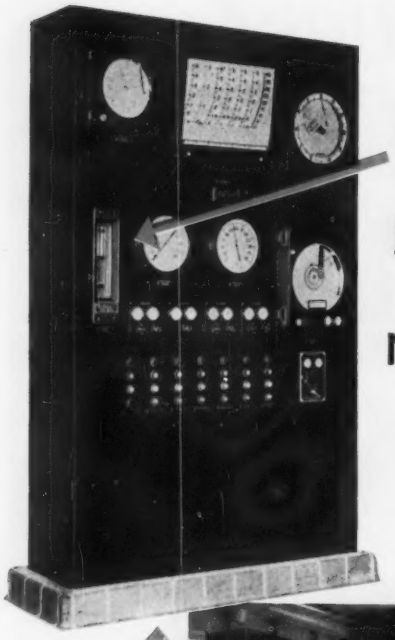
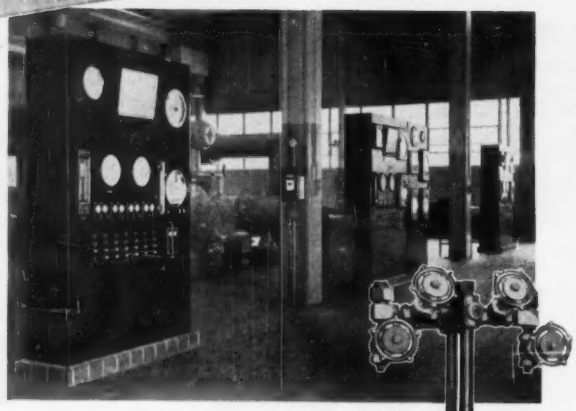


EYE-HYE

gives quick, accurate boiler water level reading for each drum at new automotive plant

Close-up of one of three panels shown below, in power plant of Chrysler Stamping Plant, Twinsburg, Ohio.

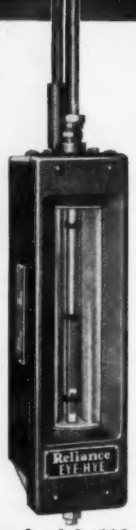


Here, as in thousands of other plants, operators "keep tab" on boiler water levels easily, quickly — with EYE-HYE conveniently mounted on panel or wall where wanted.

EYE-HYE is simple, safe, sure — easy to read from its illuminated green indicating liquid. It is sensitive to slightest level changes. Has no mechanical parts — is completely hydrostatic. Set at factory for the boiler it's ordered for; no adjustments or tampering possible on location. EYE-HYEs are available for any boiler pressure.

As an extra precaution, if warning signals are wanted, EYE-HYE can be equipped to actuate auxiliary lights and/or horns in various parts of the plant.

There are many uses for EYE-HYE Remote Reading Gages. Besides the main boilers, it can do valuable service on feed water heaters, waste heat boilers, flash tanks, storage tanks, etc. When writing for information, mention your working steam pressure.



The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

COMPRESSED AIR

Continued from page 220

amount of clearance volume as indicated in Fig. 6*d*. One or more clearance pockets connect to the head end of the cylinder through valves. The piston always sweeps out a fixed volumetric displacement V_D in the cylinder, Fig. 6 *C*.

With the clearance pocket shut off from the cylinder the cycle *1-2-3-4* measures the work input and shows the ΔV drawn in. With the clearance pocket connected through the open valve, the clearance volume increases from V_4 to V_4'. But V_D remains the same in the cylinder. On the diagram it shifts to the right, note that the chart processes no longer line up with the cylinder cross section below. Now with the piston at the crank end, the total volume has increased from V_2 to V_2'

The gas and the piston then pass through the cycle *1'-2'-3'-4'*. This shrinks the volume of air intake from ΔV to $\Delta V'$ and the work input drops from the hatched area to the gray area. Fig. 6*c* shows what happens when the clearance volume increases by four times. If we have several clearance pockets connected to the cylinder we could vary the clearance by small steps and have finer control over rate of air flow.

Next part talks about 2-stage air compressors and air engines—in a forthcoming issue.

WASTE TREATMENT

Continued from page 122

precipitates are removed by liquid-solid separation. Today's methods for inorganic waste disposal are so varied that a typical installation does not exist.

Ion exchange is used to remove harmful ions from special process water and boiler feedwater. It is also widely used in the chemical industry for purification of acids and alkalies, sugar separation and manufacture of amino acids and hormones. Metal industry uses it to recover rare metals from plating waste and remove cations from anodizing solutions. Recovery of fission products from radioactive wastes is now in its infancy.

Look for wider use of ion-exchange demineralization in waste treatment. It can remove toxic ions from specific waste streams and is particularly useful for recovering any valuable by-product materials.

WASTE-PLANT DESIGN

Here are some of the factors involved in designing a waste-treatment plant

result of an engineer's good common sense

This piping installation is here to stay, thanks to B&W Seamless Welding Fittings

THE engineer who specified B&W Seamless Welding Fittings on this boiler job knew what he was doing. He realized the system would have to be permanent and leakproof for many years to come. He also realized how much time and money could be saved in fabrication, and, of course, insulation. Therefore, it was only natural that he chose welded connections since they actually become part of the piping system and are as strong, or stronger than the pipe itself. Pipes nest closer and the overall system is considerably lighter.

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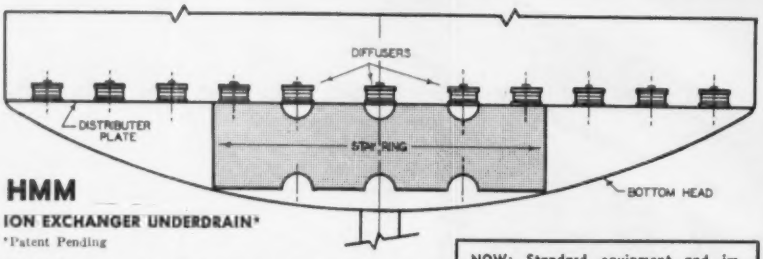

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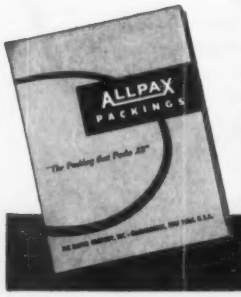

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WASTE TREATMENT

Continued from page 222

employing bio-oxidation and sedimentation to treat combined wastes from a specific industry.

Efficiency of BOD removal in the activated-sludge process depends upon time of aeration, concentration of mixed-liquor-sludge solids in aeration tanks and the magnitude of BOD loading. So it is convenient to relate this efficiency to a loading factor, usually expressed in the number of pounds BOD applied per pound of sludge in aerator tanks per day.

Primary variables in design of a continuous system are:

(a) Aeration detention period needed to stabilize a specified organic loading to a predetermined level
(b) Oxygen demand rate and air needs
(c) Sludge accumulation and disposal
(d) Nutritional needs
(e) Solids-sludge separation

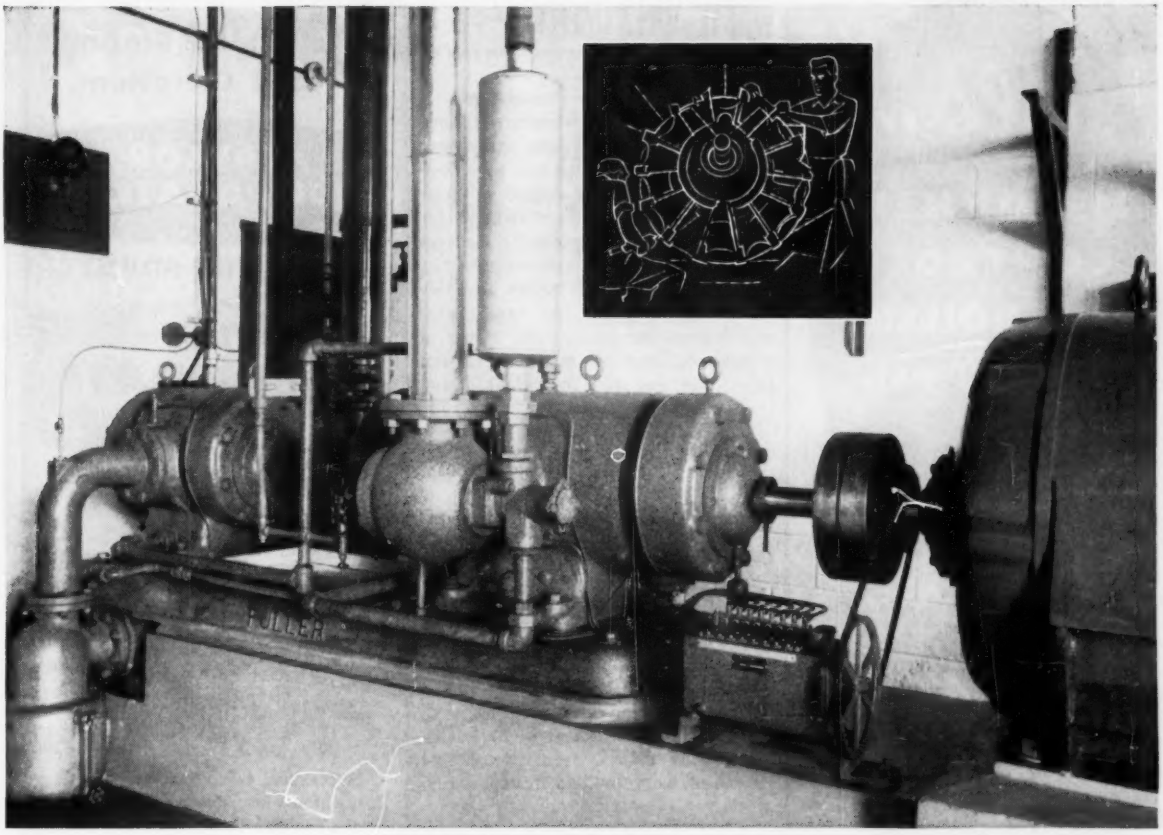
For optimum BOD removal efficiency, oxygen must be supplied to the aeration tanks at a rate equal to or greater than its rate of use by activated sludge. Oxygen utilization rate is the weight of oxygen consumed by a given weight of sludge per unit of time expressed as ppm per hr. Oxygen uptake rate includes the total need for both active and endogenous respiration. Active respiration rate varies with the quantity of sludge undergoing self-oxidation. It is expressed as a daily percentage of the sludge solids under aeration.

Total oxygen needs are related to the quantity of BOD removed and the concentration of aerator sludge solids. Dissolved-oxygen concentration in the aeration tanks must be greater than 0.2 to 0.5 ppm. High turbulence in the aeration tanks insures aerobic conditions and avoids sludge clumping.

Successful bio-oxidation calls for small quantities of nitrogen and phosphorus for sludge synthesis from BOD removed. For optimum efficiency, maintain a minimum nitrogen content of 7% and a minimum phosphorus content of 1.2% by weight of total volatile solids.

Total sludge produced by the treatment plant will consist of suspended solids present in the waste, new bacterial sludge, nonoxidizable organic matter, unoxidized stored BOD and inorganic solids. Net quantity of sludge for disposal is the total sludge produced by the system, less the quantity of bacterial sludge consumed as a result of self-oxidation.

Waste-process design and balance sheets are prepared from a statistical evaluation of laboratory, pilot plant and stream tolerance data. Design of each stage of the projected treatment



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"We were running out of air capacity, and had decided that we would like to get rid of the maintenance problems inherent in a piston type air compressor.

"The Fuller compressor with its fewer moving parts and favorable price range met our basic requirements.

"We then checked on Fuller compressor performance through our close contacts with a leading manufacturer of aircraft engines. Their opinion was very favorable. We think Airwork has made the right decision."

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- Wide seal between rotor and bottom of cylinder, assuring high volumetric efficiency.
- Rotary design assuring vibration-free flow of air.
- Direct drive.
- Compact space-saving installation.
- Simple foundation.
- No valves to leak or seats to grind.
- Few moving parts, keeping maintenance time to minimum.
- Designed for continuous duty service

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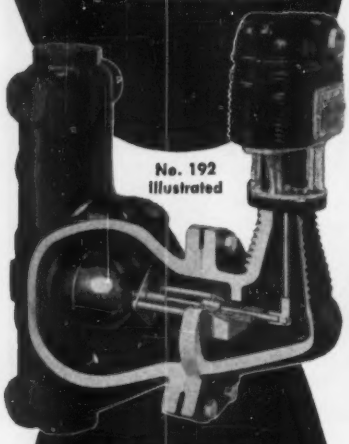


McDONNELL
92 SERIES
Pump Control, Cut-Off and Alarm Switch
Underwriters' Listed
C. S. A. Approval No. 5545

Here's a whole new concept of control design and performance . . . with the best-known name in its field. Introduces repulsion magnetic switching, for positive opening and closing. Beats the heat as never before—okayed for 75° C. (167° F.) wiring. Has extra generous float clearances; operating levels that are not affected by pressure changes; and a host of other refinements.

Write for Bulletin L-123

Shows 92 Series models with or without integral water column. Has full engineering data for controlling pumps or electric valves on boiler or tanks, for low water cutoff and alarm, etc.

Also shows companion 91 Series, for pressures to 150 psi.

McDONNELL & MILLER, INC.
3506 N. Spaulding Ave., Chicago 18, Illinois

McDONNELL
Boiler Water Level Control

WASTE TREATMENT

Continued from page 224

plant is based on these tabulations.

Capital cost for waste-treatment plants used for industrial wastes varies considerably. It depends on (1) waste volume, consistency and degree of treatment needed (2) in-plant changes for water re-use and product recovery (3) number of interceptor sewers, pumping stations and means available for sludge disposal (4) topographic and subsoil conditions (5) effect of geographic location on material and labor cost and (6) individual design standards of the industry.

My biggest boner...

has to do with a near-miss accident, which still haunts me. During my cadet training aboard ship, I was on the 4 to 8 watch helping the second assistant. I was supposed to absorb some knowledge about boilers, feed pumps and other machinery that had strange sounding names. But all I did was wander up and down ladders, peer at gages and ask questions.

One morning I was breathing down the second's neck as he was testing boiler-water samples. He tactfully suggested that I might be of service to the steamship company if I wiped the excess oil from the lube-oil purifier. I grabbed a handful of rags and climbed up to the purifier deck. This machine was the tubular bowl type, driven by a belt at 15,000 rpm. Oil supply was from gravity tanks and discharge was to main engine sump.

Well, I made one swipe at the oil with those rags—that was all. The belt took the rags and half my sleeve, and in no time filled the engine room with so much lint that it looked like it was snowing. As I stood there open-mouthed, counting my fingers, the second ran up the ladder. He immediately secured the purifier heater and oil supply. Well, I spent the rest of that watch cleaning up lint and over-flowed oil. Since then, I have become the most safety-conscious person in any plant.

P HAHN, *Easton, Pa.*

Our boner...

Alert reader *Bollaert* of the *Johnson Service Co*, referring to "Control Valves" story, Oct 1957, p 103, says that liquid flow arrows in drawing "B" should be opposite to direction shown. He's right!

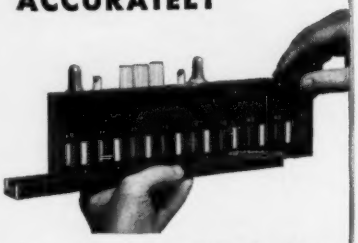
To Inhibit Scaling and Corrosion

TAYLOR COMPARATORS

HELP YOU ADJUST

pH, PHOSPHATE LEVELS

QUICKLY, ACCURATELY



By making fast, on-the-spot determinations for pH, phosphate, nitrate or silica with handy, portable Taylor Comparators, you can easily maintain proper control of boiler, condenser or cooling tower operations. In a matter of minutes you get accurate, dependable data from easy, colorimetric tests. Only three simple steps . . . fill three tubes with sample, add reagent to center tube and read result direct from slide after matching colors. Complete instructions, all necessary accessories and reagents included in every set.

WATER HARDNESS may be determined easily, yet with accuracy of an alkalinity titration, with the Taylor Total Hardness Set.

COLOR STANDARDS GUARANTEED

Be sure to use only Taylor reagents and accessories with Taylor Comparators to assure accurate results. All Taylor liquid color standards carry an unlimited guarantee against fading.

SEE YOUR DEALER for Taylor sets or immediate replacement of supplies. Write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes full Taylor line.

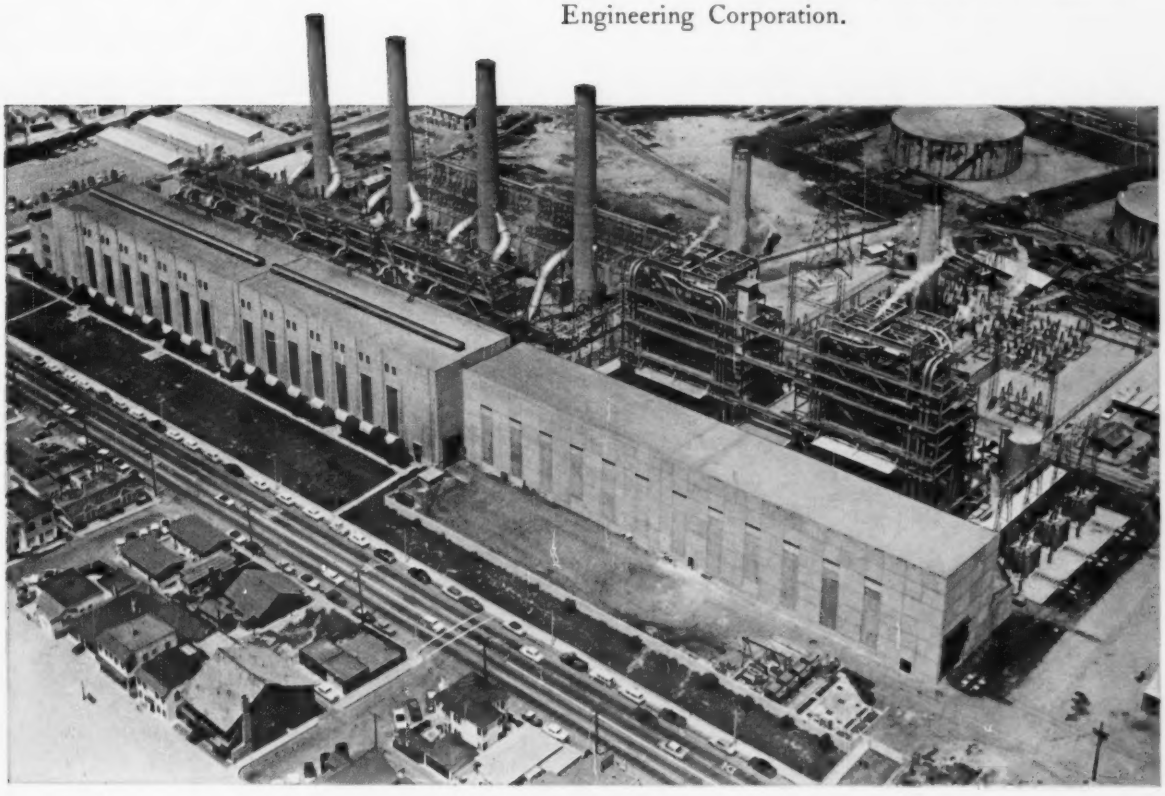
W. A. TAYLOR AND CO.
YORK RD. & STEVENSON LANE • BALTO.-4, MD.

RETURN TO REDONDO

Unit #6 of the Redondo Steam Station of the Southern California Edison Company went into commercial operation less than 22 months from the time Stone & Webster Engineering Corporation received authorization to proceed with design and construction.

This unit with a capacity of over 150,000 kw was designed to operate on gas and/or oil. Complete remote controlled furnace ignition and combustion control permits firing of Units #5 and #6 by either fuel from a centralized control room.

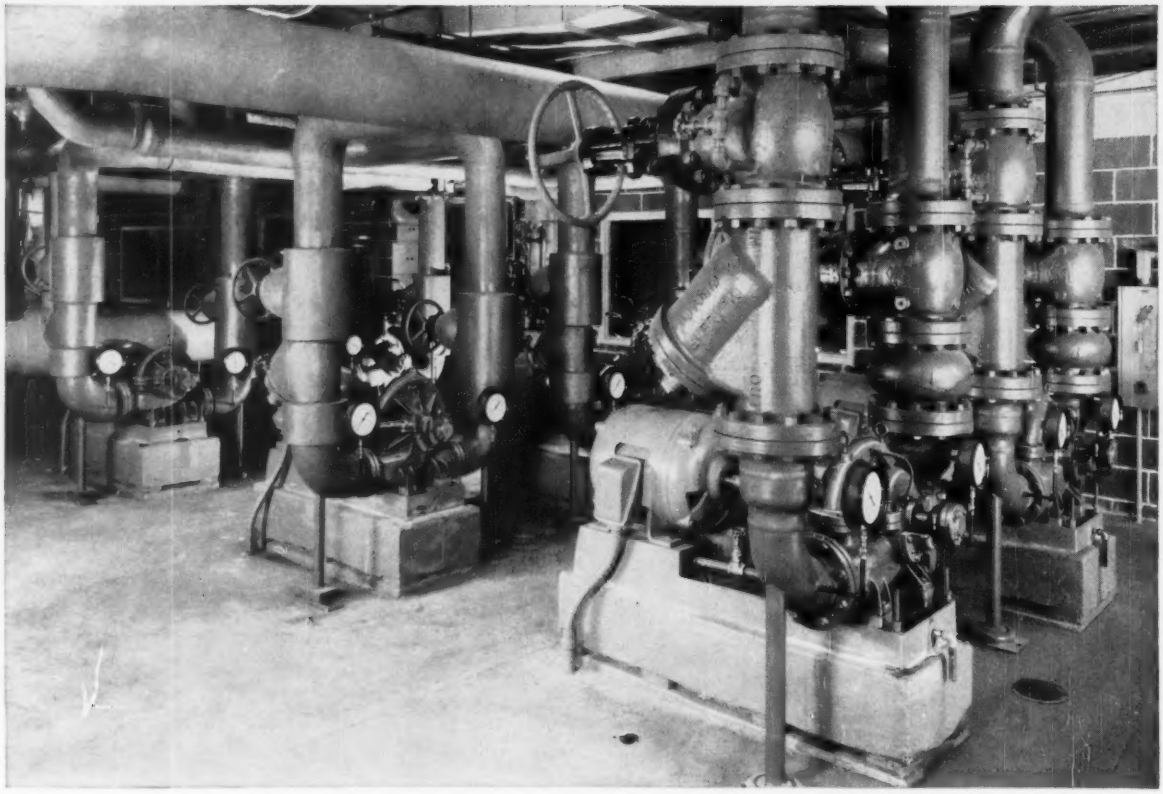
A second control room serves Units #1 through #4 in a similar manner. Together they permit effortless operation over a wide range of load at minimum operating cost. All six units were designed and constructed by Stone & Webster Engineering Corporation.



Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION
A SUBSIDIARY *of* STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto



How do you guarantee successful pump installations?

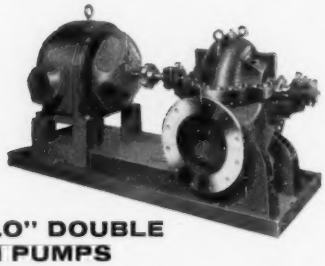
Many rely on these "Buffalo" Pumps

There's a "Buffalo" Pump that's sure to fit your installation needs perfectly . . . sure to deliver the utmost in economy, reliability and long-lasting performance on the job. For *two* reasons: *First* . . . "Buffalo" builds a line of pumps covering almost every type of liquid-moving requirement. All you do is select the *one* "Buffalo" Pump that exactly matches your installation needs. *Second* . . . When you choose your "Buffalo" Pump, you can be sure you're installing the very finest. For more than 80 years, engineers and contractors have relied on the rugged, dependable quality built into every "Buffalo" Pump. You can *depend* on "Buffalo" Pumps.

Whatever your pump problem, write us for engineering data. We'll gladly submit recommendations that will help you with your liquid-moving requirements.

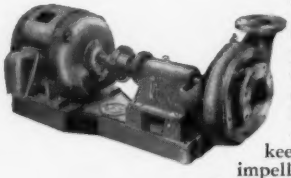
BUFFALO PUMPS
Division of Buffalo Forge Co.
488 Broadway Buffalo, N.Y.
Canada Pumps, Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



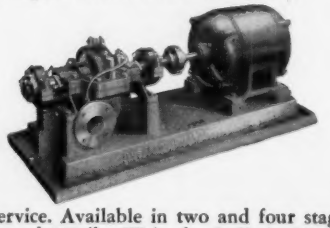
"BUFFALO" DOUBLE SUCTION PUMPS

These pumps are designed for the finest performance possible in clear water service in 10 to 14,000 gpm capacities. Widely used for air conditioning service, because of their peak efficiency. Write for Bulletin 955-Q.



"BUFFALO" SINGLE SUCTION PUMPS

Husky pumps for husky jobs, with these outstanding features: oversize bearings capable of handling speeds up to 5000 rpm — sealed-in bearing housing to keep out foreign matter—enclosed impellers, to retain initial efficiency. Complete details in Bulletin 976-E.



"BUFFALO" MULTISTAGE PUMPS

"Buffalo" Type "RR" Multistage Pumps are highly efficient for high pressure applications with clear water. Ideal for boiler feed service. Available in two and four stage designs, up to 900 gpm and 500 lbs. Write for Bulletin 980-D.

PRE-SET COMPENSATING SPRINGS ASSURE TIGHT VALVE SEAT...

where variable high line temperatures are encountered

specify LimiTorque type SA valve controls . . . with compensating springs

Correct seating of the valve is extremely important during automatic valve operation, especially where fluctuation of high line temperatures are encountered.

To assure an absolutely tight seat, the new LimiTorque Type SA Unit incorporates unique compensatory springs which, literally, "takes up" any amount of contraction or expansion caused by decreasing or rising line temperature.

These springs of Belleville Disc type vary in number for use in either parallel or series, within fixed limits, to provide the desired compensation. The result of continual improvement and development, the Type "SA" LimiTorque contains all the features of the famous Type SMA unit plus a simple indicator to show the amount of compensating spring compression. Available in Weatherproof and Explosion proof construction, these units can be mounted on any size valve in almost any position.

For more specific information and data write for Bulletin 4-57 on your business letterhead.

LimiTorque®

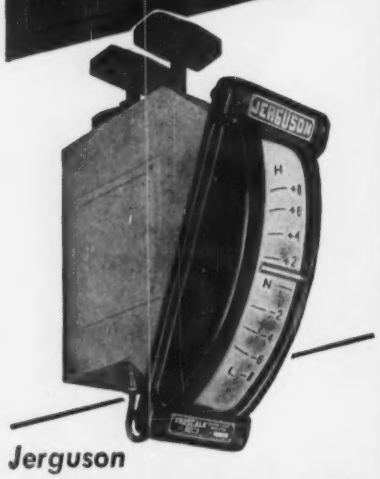
PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS
LIMITORQUE VALVE CONTROLS
FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

Now you can
Have Your Gages
Face UP or DOWN



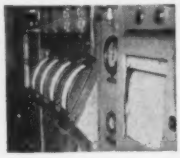
Jerguson

NEW INCLINED TRUSCALE

Remote Reading Gages

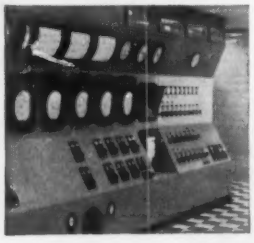
Have your Remote Reading Gages face up or down . . . to fit low or high installations. Inclined Truscales built with case and scale inclined either upward 35° or downward 24°.

Truscales give you accuracy of ½ of 1% of scale reading and full 180° visibility with scale markings directly on convex face.



Truscale Gages inclined upward in fireroom of SS Flandre

All types of warning signals: Flashing red scale, signal horns, lights and up to six repeaters.



Truscale Gage inclined downward on control panel at Florida Power Corp.

Send for Data Unit on Truscale Inclined Gages.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Bailey Meters & Controls, Ltd., London, Eng.
Controle Bailey, Paris, France

More FREE LITERATURE

Begins on page 191

ject of 4-p illustrated bulletin GEA-6750. Gives enclosure information, ratings, modifications and accessories of line. Circuit Protective Devices Dept, General Electric Co, Plainville, Conn.

11 **Thermostat** for equipment using two heating elements is described in illustrated bulletin RT-807. Has application and installation information. Robertshaw - Fulton Controls Co, 110 E Otterman St, Greensburg, Pa.

ELECTRICAL EQUIPMENT

12 Silicone application is subject of 8-p illustrated catalog CDS-97. Diagrams of physical and electrical properties are included. General Electric Co, Silicone Products Dept, Waterford, N. Y.

13 **Care of electric motors** is explained in 16-p handbook. Problems of moisture, friction, overload and underload are discussed. Chicago Electric Co, 1318 W Cermak Rd, Chicago 8, Ill.

14 **Converters,** dc to ac, are described in catalog 557. Contains illustrated listings of converters, performance charts, dimensions, selector charts. Carter Motor Co, 2711A W George St, Chicago, Ill.

15 **Duplex-type transformers** are subject of 8-p illustrated booklet 1757. Construction design and details, mechanical and electrical data are given for transformers from 2400 through 13,200 v. Load curve; connection diagrams included. Pennsylvania Transformer Div, McGraw-Edison Co, Box 330, Canonsburg, Pa.

16 **Connectors,** subminiature series, are listed in 12-p brochure. Specs, outline drawings, illustrations, general information included. Electronic Sales Div, DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1, N. Y.

MAINTENANCE EQUIPMENT AND MATERIALS

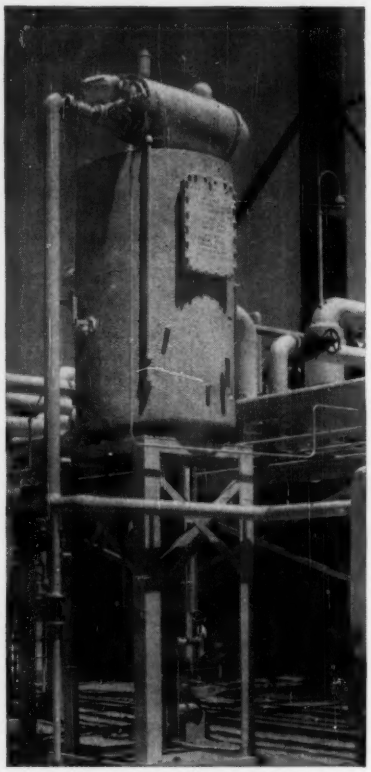
17 **Concrete floor surfacing** for industrial and commercial use is treated in illustrated 4-p booklet. Pictures show installation. Kalman Floor Co, 110 E 42nd St, New York 17, N. Y.

18 **Rubber-tile floor** maintenance is described in 4-p bulletin 1402. Gives step-by-step instructions for initial treatment, daily maintenance and restoration. Multi-Clean Products, Inc, St. Paul 16, Minn.

MECHANICAL TRANSMISSION

19 **Ball and roller bearings;** other products are described in 88-p catalog AG-57. Book includes engineering-data section, complete specs on ball-thrust bearings, washers and retainers, mounted

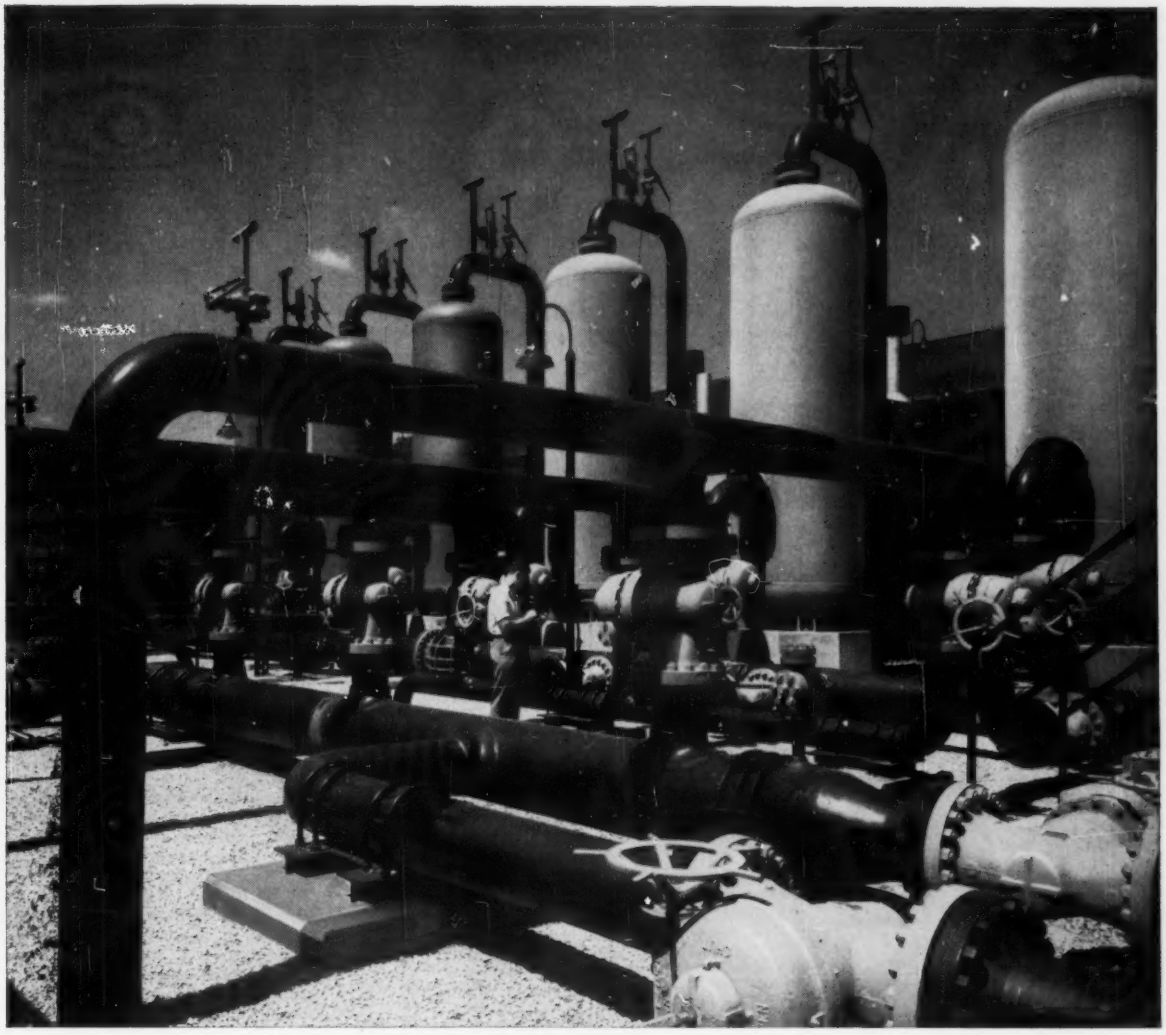
How to solve a feed water problem



A Texas oil refinery needed a packaged ˝sed water heater rugged enough for exterior installation, and capable of delivering water at specified temperature even with 1" or more of encrustation on tray surfaces. Selected for the job was the Stickle unit shown above. Extra deep trays force water to flow irregularly in a thin film, depositing solids and releasing noncondensable gases. Trays cannot overflow; are easily removed for cleaning. Open coils bring feed water into direct contact with steam, immediately transmit heat to water. Condensed steam is not wasted. It provides one-sixth of boiler feed supply. There's a Stickle feed water heater for practically every need. Capacities 3,000 to 300,000 lbs. per hr. Stickle has built heaters since 1905; is well equipped to solve your feed water problem. Write for free bulletins.

STICKLE STEAM SPECIALTIES CO.
2265 Valley Ave. • Indianapolis 18, Ind.

Stickle Equipment
Cuts the cost of steam



Original station and expansion...
BOTH BY DRAVO

United Fuel Gas Company's compressor station at Lanham, West Virginia, was built by Dravo to route gas from the southwest for storage or for use in the eastern and northern markets.

Increased demands called for an addition to double the original capacity of the station. Three compressors, jacket water cooler, gas cooler and three gas scrubbers, together with the necessary building extension, were installed. The contract also included the fabrication and erection of all piping for the fuel gas, oil and water lines as well as for the gas lines.

Space limitations required compact design. The erection of new equipment and piping had to be accomplished without interrupting normal operation. Despite these handicaps, the addition was completed on schedule.

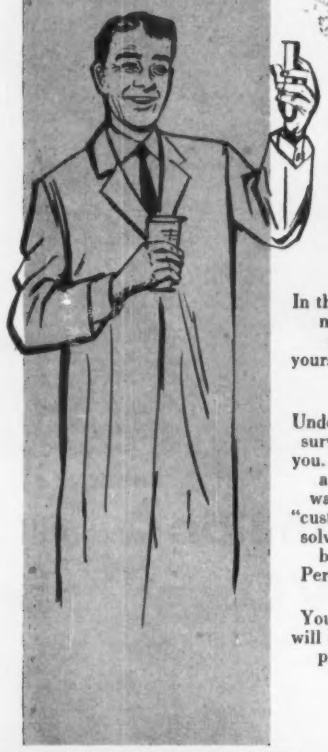
You, too, can profit from Dravo's single-contract responsibility for the fabrication and erection of piping and complete facilities. For information, write DRAVO CORPORATION, PITTSBURGH 25, PA.

DRAVO
CORPORATION

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

Eliminate Boiler Feedwater Problems with DEADY

DEADY Products, Recommendations and Service



There's only one way to keep your boiler feedwater operation efficient. That's by preventing and/or correcting water problems by thorough analysis and investigation of the "problem". Deady Chemical Company has been a specialist in individualized treatment of water problems since 1905.

In that time, Deady engineers have met and mastered every type of industrial water condition and problem. You can avail yourself of Deady's formulated products and specialized know-how through the Deady Service Plan.

Under this plan, Deady Service Engineers survey your particular needs at *no cost* to you. As part of their survey, they will make a complete laboratory analysis of your water supply. After thorough study, the "custom-made" Deady Recommendations to solve your water conditioning problem will be presented to you without obligation. Periodic Deady *Service* "Check-ups" make sure your water is properly treated.

Your small investment in Deady products will be repaid many times over in the plant protection you'll receive. Why not write for the illustrated folder describing the Deady Plan in detail? No obligation, of course.

DEADY

Say: DEE-DEE

DEADY CHEMICAL COMPANY

1401 Fairfax Trafficway
Kansas City 15, Kansas

•

3757 Wilshire Boulevard
Los Angeles, California

Field Service Engineer Headquarters:

Kansas City, Kans.
St. Louis, Mo.
Chicago, Ill.
Milwaukee, Wisc.
Omaha, Nebr.
Davenport, Iowa
Minneapolis, Minn.
Detroit, Mich.
Indianapolis, Ind.
Fort Wayne, Ind.
Cincinnati, Ohio
Toledo, Ohio
Denver, Colo.
Tulsa, Okla.
Los Angeles, Calif.
San Francisco, Calif.
Seattle, Wash.
Pittsburgh, Pa.
Memphis, Tenn.
Chattanooga, Tenn.
Charlotte, N. C.

More FREE LITERATURE

Begins on page 191

radial - bearing units, clutch - release bearings. Aetna Ball & Roller Bearing Co, 4600 Schubert Ave, Chicago 39, Ill.

20 **Flexible cushion coupling** is subject of 12-p illustrated bulletin A-669. Full-view photos, cutaway drawings show construction, installation features. Tables included. Dodge Manufacturing Corp, Mishawaka, Ind.

21 **Miniature bearings** are discussed in 24-p catalog. Describes standard radial miniature bearings ranging in size from 1/10-in. to ⅜ - in. Bore - dimension charts given for all types. Miniature Precision Bearings, Inc, Keene, N. H.

METALS AND ALLOYS

22 **Stainless-steel sand castings** are described in 4-p illustrated brochure 12249. Discusses types and applications of castings. Specs of common stainless-steel alloys included. Alloy Steel Castings Co, 249 County Line Rd, Southampton, Pa.

23 **Iron-nickel steel** is subject of 20-p data sheet. Gives detailed information on typical physical, mechanical and magnetic properties. Includes 16 graphs. Advertising Dept, Allegheny Ludlum Steel Corp, Oliver Bldg, Pittsburgh 22, Pa.

24 **Zirconium and hafnium** booklet contains 12 pages. Describes uses of metals, gives data on alloy systems and fabrication of zirconium parts. U.S. Industrial Chemicals Corp, 99 Park Ave, New York, N. Y.

25 **Carbon and graphite** products for chemical-processing and other industries are listed in 4-p bulletin S-5008. Provides data on shell and tube heat exchangers, centrifugal pumps, piping, valves and fittings. National Carbon Co, 30 E 42nd St, New York 17, N Y.

PIPING, VALVES, FITTINGS

26 **Plastic ductility** of piping containing welded joints at 1200 F is subject of 16-p report. Deals with materials selection, stress-rupture characteristics. Pittsburgh Piping and Equipment Co, 158 49th St, Pittsburgh, Pa.

27 **Polyvinyl chloride pipe,** corrosion-resistant rigid type, is described in 12-p catalog. Tables of applications; temperature factors included. Alpha Plastics Inc, 78 Okner Parkway, Livingston, N. J.

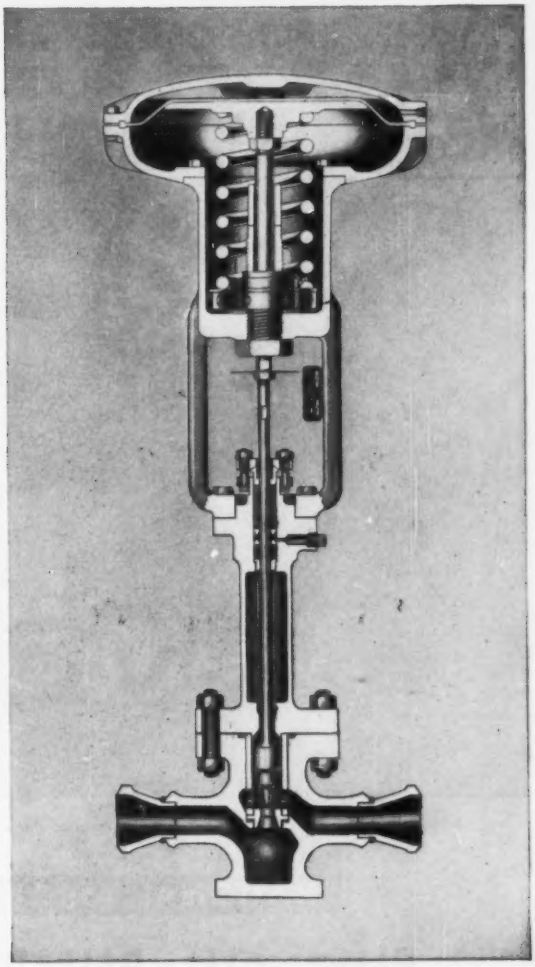
28 **Thermostatic - expansion valves** are described in 6-bulletin package. Complete technical information on valves emphasizes mechanical data. Application information, complete specs are given. Controls Co of America, 2450 N 32nd St, Milwaukee, Wis.

This advertisement is a round-up of recent advances in utility control valves.

How do you design control valves for high pressure — temperature services about which little is known?

Leslie engineers faced this problem when asked to develop control valves that would allow utilities to cross the threshold into Btu-saving, high pressure — temperature steam generation.

Tomorrow's utility control valves today



The Leslie Class DLHS-2 Diaphragm Control Valve has shown remarkable resistance to erosion in high pressure, high temperature service.

Called upon to develop control valves with maximum resistance to erosion and corrosion in high pressure, high temperature steam and boiler feedwater services, Leslie engineers had two factors in their favor—a 50-year tradition of introducing new ideas in steam controls and the ability to get to the root of a problem fast, and objectively.

What Resulted

Not only have valves with remarkable resistance to erosion been put into service but they were the first valves ever introduced for services as high as 2500 psi, 1050 F with renewable trim that can be completely changed in 15 minutes downtime!

Leslie pioneered new uses of hard facing alloys for high pressure, high temperature control valves, just as it pioneered the use of stellite in normal pressure ranges over 20 years ago, when it became the standard seating surface for all Leslie steam regulators and control valves.

Companion Developments

Companion developments for tomorrow's high pressure and temperature control valves include the industry's first large size, fully balanced, single seated control valve, in sizes up to 16 inches; its first self-contained regulator to act as a combination pressure reducing and remotely operated shut-off valve in soot blower service, and the industry's first remote manual valve for centralized control of start-up drains.

For the "Day After Tomorrow"

A startling new concept in high pressure control valves—one that offers increased rangeability and throttling action with tight shut-off is now being made ready for field tests in high pressure applications. Other designs incorporate a new "protected seat" feature for maximum erosion resistance under extreme pressures and flashing mixtures.

These advances also reflect the kind of engineering incorporated in the broad line of standard Leslie control valves suited for many normal-pressure, utility services. But more important, we like to think that these advances justify the faith placed in Leslie Co. by the power industry in providing new opportunities and challenges to design and produce controls for the applications of tomorrow's steam generating stations.

Three Special Data Sheets Available

The following Engineering Data Sheets are available on request from Leslie Co., 235 Grant Avenue, Lyndhurst, New Jersey:

- Selection of Control Valve Body and Trim Material for Flashing Mixtures.
- Flow of Flashing Mixtures, Globe type Bodies.
- Viscosity Correction for Sizing Control Valves.

LESLIE

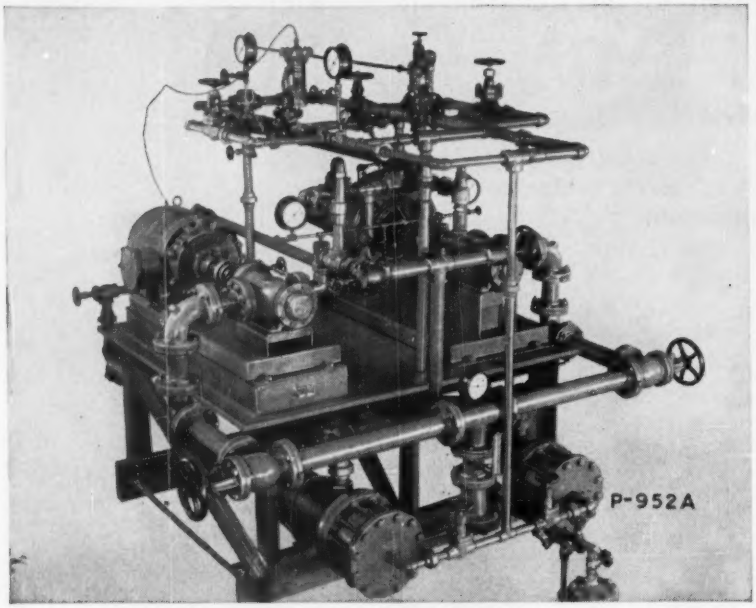
REGULATORS AND CONTROLLERS

LESLIE CO., 235 GRANT AVENUE, LYNDHURST, NEW JERSEY

881

COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER..



P-952A Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40 — very interesting and informative.

- OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
- STEAM ATOMIZING OIL BURNERS
- SLUDGE BURNERS, Steam Atomizing
- MOTOR-DRIVEN ROTARY OIL BURNERS
- MECHANICAL PRESSURE ATOMIZING OIL BURNERS
- DUAL STAGE, Combining Steam and Mechanical Atomization
- LOW AIR PRESSURE OIL BURNERS
- AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
- GAS BURNERS
- COMBINATION GAS and OIL BURNERS
- FUEL OIL PUMPING and HEATING UNITS
- FURNACE RELIEF DOORS
- AIR INTAKE DOORS
- OBSERVATION PORTS
- SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

Main Office and Factory: 1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

APPOINTMENTS

Corporation executive changes

American Brake Shoe Co, Manganese Steel Div: Joseph L Mullin, executive vice-president. **Western Kentucky Gas Co:** C J Tankersley, president. **Sperry Rand Corp,** Ford Instrument Div: Charles S Rockwell, president and general manager. **Public Service Electric & Gas Co:** Frank Freer, Jr, comptroller. **Textron Inc,** Homelite Div: Nelson Thompson, executive vice-president. **Aldrich Pump Co:** Carl H Vaupel, vice-president and general manager.

Griswold-Eshleman Co: vice-presidents: Edmond C Powers; Robert L Baumgardner. **Ford, Bacon & Davis Inc:** vice-presidents: L S Baldin; S R Fleming; W O Johnson. **Yuba Consolidated Industries Inc,** Yuba Heat Transfer Div: W E Brockel, vice-president of engineering; N S Livingston, vice-president. **The Ramo-Wooldridge Corp:** vice-presidents: Dr Ruben F Mettler; Dr Burton F Miller; Milton E Mohr. **Square D Co:** Lawrence G Maechtlen, vice-president. **M W Kellogg Co:** Dr Alex G Oblad, vice-president of research and development. **Wallace & Tiernan Inc:** Robert T Browning, executive vice-president.

Operations executive changes

Graybar Electric Co Inc: W D Anderson, Corpus Christi operating manager: W B McGhee Jr, Jackson, Miss. operating manager. **Miehle-Goss-Dexter, Inc:** Miehle-Dexter Supercharger Div: Dr Klaus C Karde, director of engineering, research and development. **York-Shipley Inc:** Gordon M Parker, merchandising manager. **Burroughs Corp,** ElectroData Div: Frank C Mears, field-engineering supervisor. **Harper Electric Furnace Corp:** H M Webber, process-engineering manager. **American Brake Shoe Co:** Maj. Gen. Roger J Browne, USAF, director of defense products.

Babcock & Wilcox, Barberton Works: John J McDermott, production manager. **Youngstown Sheet & Tube Co,** Campbell Works: Edward O Reese, manager. **Keasbey & Mattison Co:** Ralph L Lanz, planning and inventory dept manager; Charles R Meek, quality control manager; **Robert M Russell,** supervisor of production and planning. **Du Mont Laboratories Inc:** William G Fockler, technical-products engineering manager.

Engineer changes

Rockbestos Products Corp: Francis B Becker, industrial engineer. **H K Porter Co,** Leschen Wire Rope Div: Dr Ottilie Amminger, chief metallurgist. **Askania Regulator Co:** Werner

THE MEANING OF FLEXITALLIC BLUE

In every field of high-pressure seal—for pipe flanges, pressure vessels, and process equipment—engineers know and recognize Flexitallic Spiral-Wound Gaskets. The blue dye in the Canadian asbestos filler provides positive product identification.

Flexitallic Blue tells the user that the gasket is made by an engineering organization devoted exclusively to the manufacture of Spiral-Wound Gaskets since 1912.

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Wears longer than steel . . . non-skid under oily conditions . . .

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abrasive embedded grating

Reliance Relgrit abrasive embedded grating and treads provide the only truly non-skid surface. Even when covered with oil, Relgrit has a coefficient of friction 30% greater than dry steel grating. Wear tests have shown that the abrasive surface will wear longer than steel, and retain its non-skid quality during its entire service life.

The top surfaces of the bearing and cross bars have ⅛" deep V-grooves in which is embedded abrasive aluminum oxide grains in a hard resin. The material is not affected by water, oil, gasoline, greases, or commonly used acids, alkalis and other chemicals. Together with its wear resistance, this gives Relgrit a long service life.

If you have floors or stairs which become oily, greasy, wet, or slick from any cause, Relgrit can provide safe footing at very low cost. Write on your letterhead for free sample and literature, or ask for our representative to call. It will pay you to investigate this remarkable new grating.

*you can't slip on Relgrit**

*Patent applied for

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Relgrit Abrasive Gratings and Treads • Lightweight Bridge Flooring
Steel, Stainless and Aluminum Grating • Steel Mill Equipment

More APPOINTMENTS

Begins on page 234

G Holzbock, chief engineer. **Burroughs Corp:** George A Baird, associate director of engineering. **Philips Electronics Inc:** James E Weidenborner, staff analytical chemist.

B F Goodrich Chemical Co: Charles L Woods Jr, plant engineer, Louisville. **Allis-Chalmers Manufacturing Co:** Warner C Frazier, application engineer. **Consolidated Electrodynamics Corp:** Herbert I Chambers, chief development engineer; Francis T Greenup, chief product engineer. **Simpson Electric Co:** Frank Hadrick, chief field engineer. **Burroughs Corp,** ElectroData Div: John T Allen, field engineering supervisor, Dallas district. **Babcock & Wilcox Co,** Tubular Products Div: metallurgist supervisors: John F Beck, technical service; Clark P Church, process development; Dr John F Ewing, research. **Robbins & Myers Inc:** V Mueller, development engineer.

New Distributors

For **Automatic Switch Co:** Terco Equipment Co, 939 Howard St, San Francisco 3, Calif. For **Tuthill Pump Co:** Hydraquip Corp, 6645 Navigation Blvd, Houston, Texas; Ernest Ritchie Co, 1305 South Ivanhoe Way, Denver 22, Colo. For **U.S. Rubber Co:** W S Nott Co, Minneapolis.

New district offices

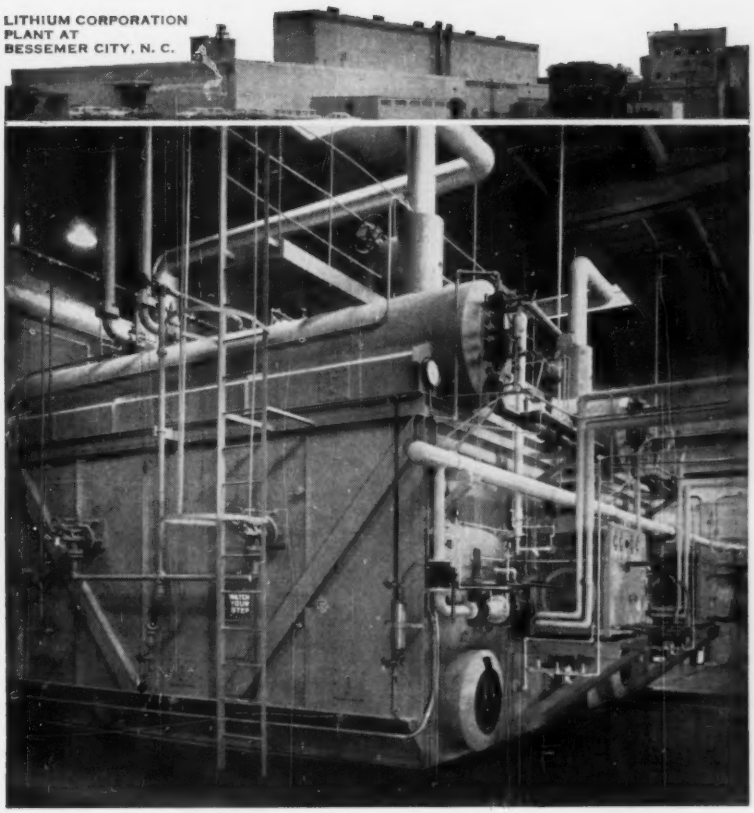
Weston Electrical Instrument Corp: 147 10th St, San Francisco, Calif. **The Fairbanks Co:** 2600 S Throop St, Chicago, Ill. **Johnson Service Co:** 19 Eastern Ave, East Syracuse, N. Y. **Carrier Corp,** Machinery & Systems Div: 2727 Wesleyan, West Alabama, Texas. **Allis-Chalmers Manufacturing Co:** 11 W Monument St, Dayton, Ohio. **Babcock & Wilcox Co:** Refractories Div.: Rm 408, News Bldg, 725-31 Broad St, Augusta, Ga.

New Representatives

For **Buensod-Stacey Inc:** E K Strahan Inc, 617 Julia St, New Orleans, La.; H Dewey Co, Columbus, Ohio; General Equipment Co, Spokane, Wash. For **Fisher-Pierce Co:** L R Ward Co, Dallas and Houston, Texas. For **Spencer Turbine Co:** John Betzhold, Rose Cook, Inc, Los Angeles.

For **Clark Controller Co:** Sidney W Nelson, Cincinnati District. For **Standard Transformer Co:** The Bradley Co, 3341 Arch St, Philadelphia 4, Pa. For **Cleaver-Brooks Co:** Automatic Boiler Service & Equipment Co, 130 W Chippewa St, Buffalo 2, N. Y. For **Allis-Chalmers Industries Group:** C C Jordan, southeast region. For **Lake Shore Electric Corp:** The Herbert J Baer Co, Box 131, Richmond, Va.; The C B Rogers Co, Box

LITHIUM CORPORATION PLANT AT BESSEMER CITY, N. C.



Industry's blistering pace demands...

ALL-OUT BOILER PERFORMANCE LIKE LITHIUM CORP. IS GETTING

Lithium, the "Horatio Alger" metal, is making an impact on every segment of industry... and Lithium Corp. of America's plant at Bessemer City, N.C. is meeting the mushrooming demand by peak load refining. This processing requires high pressure steam for vacuum jet equipment, a load of 60,000 lbs. per hr. at 140 psi. on the two Bros Packaged Boilers.

This peak load boiler performance is important, of course. Another big point in the Lithium plant boiler room is nominal maintenance; water tube inspection of these Bros boilers after 15 months of near-capacity operation showed *no scale formation.*

That's the kind of performance that makes a real hit with boiler engineers; yet Bros-engineered flexibility and economy pay off in the front office, too. Here's why:

Complete factory-assembled units. Bros Packaged Boilers are self-contained units, easy to transport and easily installed at low cost. They go on-the-line with simple service connections... no time or money wasted on slow, costly erections at the plant. These boilers quickly respond to varying loads; they supply steam requirements often expected only of larger, more expensive boiler equipment.

Capacities range from 4,000 lbs. steam per hour and up. Whatever your steam needs, Bros has the precise Packaged Boiler for the job. These units burn oil, gas, or both. Equipped with fully automatic, semi-automatic or manual controls.

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75TH YEAR

POWER DIVISION

BROS *Incorporated*

(formerly Wm. Bros Boiler & Mfg. Co.)

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SUPERGAUGE®

. . . built to last a lifetime!

HERE'S WHY:

- The heart of a gauge is the movement—actually a sector and pinion combination which converts travel of the Bourdon tube to the rotary motion of the pointer.
- The USG Arc-Loc® Movement permits all calibration adjustments of the internal assembly from the rear without removing dial and pointer.
- Sector is stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.
- Mono-Unit Construction permits easy removal of complete gauge movement assembly for inspection and adjustment.

Supergauges are available in 4½", 6" and 8½" sizes, for pressures to 20,000 psi. Call your local USG Distributor today . . . see the "Yellow Pages" of your phone book . . . or write for complete information on gauge styles and construction.

USG UNITED STATES GAUGE

Home of the SUPERGAUGE

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MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

More APPOINTMENTS

Begins on page 234

1376, Clearwater, Fla. For **The Bristol Co:** R E Helsabeck, Houston office; George K Foster, Cincinnati office; C A Rust, Los Angeles office. For **Copeland Refrigeration Corp:** John Young, S Illinois district; Louis A Wallace, Texas and Oklahoma.

Institute elections

Instrument Society of America: Robert J Jeffries, president; Henry C Frost, president-elect-secretary. **Illuminating Engineering Society:** Kirk M Reid, president; Joe B Browder, vice-president; James R Chambers, treasurer. **American Society of Civil Engineers:** L R Howson, president; Waldo G Bowman and Samuel B Morris, vice-presidents. **American Assn of Cost Engineers:** Edward D Shanken, executive secretary.

Awards

Joe Jopling: national gold certificate in Class I, 3rd Product Development contest of Steel Founders' Society of America. **Donald N Rosenblatt:** national gold certificate in class II, 3rd Product Development Contest of Steel Founders' Society of America. **Donald A Quarles:** award of merit, American Institute of Consulting Engineers. **Reginald James Seymour Pigott:** Elliott Cresson Medal of The Franklin Institute. **Robert L Bartlett** and **Heinrich Hegetschweiler:** Prime Movers Committee award of ASME. **Arthur E Raymond:** Daniel Guggenheim Medal "for notable achievements in the advancement of aeronautics." **Leon Brillouin:** NEC Award of Merit. **I M Horowitz,** NEC Annual Award.

Retirements

George W Tall Jr, vice-president & secretary of Leeds & Northrup Co, after 42 years of service.

Dr Edgar C Bain, assistant executive vice-president of operations, United States Steel Corp, after 30 years of service.

William H Lachman, production manager, Keasbey & Mattison Co, after 53 years of service.

Fred Aimmerman, sales vice-president, Broderick & Bascom Rope Co, after 46 years of service.

Obituaries

William J Magee, 68, retired treasurer and director of the Norton Co, on August 26.

Raymond B Elmendorf, 51, manager of marketing, General Electric Conduit Products Dept, on August 26.

Philip J Wenz, 63, manager of Service and Repair Division of De Laval Steam Turbine Co, on September 11.

Hall Industrial Water Report

VOLUME 5 DECEMBER 1957 NUMBER 6

Keep Water Out of Steam

Water belongs in the boiler or evaporator, not in the steam. Wet steam from priming or foaming of boilers may seriously damage superheaters or turbines. Evaporator vapor of poor quality introduces excessive amounts of solids to the boiler feed cycle.

Carryover problems can be solved. Mechanical changes may be the most economical answer. Perhaps the water level should be lowered, or its variation controlled more carefully, or maybe the baffles in the steam drum should be altered. But the problem may be a chemical one. Is there unsuspected contamination of condensate or feedwater? Or is the answer simple adjustment of blowdown or use of an effective antifoam? Hall engineers are experienced in searching for the best way to avoid wet steam. They stand ready to help you.

More Blowdown

A Georgia plant, plagued with gross carryover from a small HRT boiler, had tried unsuccessfully to solve the problem with a number of compounds offered as effective cures. Usually the compounds aggravated the condition. Finally, Hall Laboratories was called in to help.

Hall field engineer John Kenney quickly diagnosed the problem. Little attention was given to blowdown of the boiler, so the total solids in the boiler water frequently ran much too high. After Kenney gave the operators the proper test procedures to control boiler water conditions and trained them to maintain total solids concentration at a satisfactory level, the difficulty was completely eliminated.

Simple, wasn't it? But only after a Hall engineer applied his training and experience to finding the actual cause of the carryover.

Dye Bath Trouble

In spite of heavy blowdown, careful control of boiler water conditions and normal boiler steam loads, a New England finishing plant experienced serious difficulty in dyeing operations because of impure steam. Conductivity tests on samples of condensed steam from the bleach house showed continuous carryover with dissolved solids ranging from 14 to over 300 ppm.

There was little if any room for improvement in boiler water conditions. There was no detectable contamination of boiler feedwater that could easily be eliminated. There was no simple mechanical solution to the problem. Hall field engineer Bob Dow decided accordingly to feed Hagan C-1 Antifoam. Carryover stopped immediately. Conductivity tests on samples collected under the same conditions as before showed only a trace of dissolved solids.

Further work indicated that with the use of the antifoam, blowdown could be cut in half with savings in water and chemicals. Needless to say, plant management is happy with Hall Laboratories service.

Hammers Stopped

The makeup water which constitutes about 70 percent of the feedwater at a forge plant in California contains 325 ppm hardness and 800 ppm dissolved solids. In addition, the condensate available and the exhaust steam used for feedwater heating are heavily contaminated with cylinder oil.

When Hall field engineer Dick Carey tackled the job he found boiler water level fluctuating badly and so much water in the steam that the continual stopping of the forging hammers was seriously interfering with production.

The only change that could be made at once was the feeding of Hagan H.P. Antifoam. This turned out to be all that was necessary. The water level stopped fluctuating, carryover ceased and so did any difficulty at the hammers.

Water is your industry's most important raw material. Use it wisely.

Foaming Traced to Size

During a regular visit to a New York paper mill, Hall field engineer Lou Eppelsheimer was informed that water was foaming in a condensate pump and that a heavy deposit had built up on a turbine throttle valve in a week's time.

Subsequent analysis showed the condensate to have a high pH value and to contain raw water, considerable silica and much organic matter. The deposit on the turbine throttle contained boiler water salts, indicating carryover. A most significant clue was that the foaming condition occurred only on Mondays.

With this information as a guide the plant men and the Hall engineer were able to pinpoint the difficulty. In the plant, the size emulsion was prepared with raw water, a silica compound and glue. The hot mixture was transferred from one tank and atomized into others with a steam injector. When steam pressure dropped over weekends the emulsion was sucked back into the steam lines. As operations were resumed on Monday, the contamination was flushed through the traps into the condensate return system.

Suitably placed check valves and regular examination of condensate have eliminated all difficulty.

Dr. Partridge Honored

When industrial water was selected as the 1957 topic for the Annual Marburg Lecture of the American Society for Testing Materials, Dr. Everett P. Partridge, Director of Hall Laboratories, was chosen as the lecturer. At the ASTM meeting in June, Dr. Partridge showed where we stand as a nation with respect to what he called "Your Most Important Raw Material." Reprints of his lecture will be available.

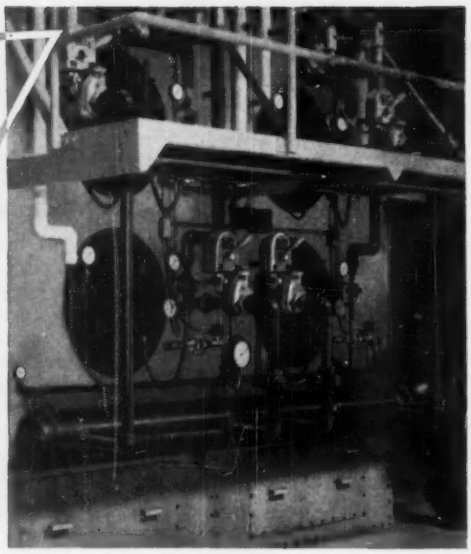
Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Division of Hagan Chemicals & Controls, Inc., Hagan Building, Pittsburgh 30, Pa.

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

ENCO BURNERS FOR OIL, GAS OR TAR

Steam Or Mechanical Atomizing 1 TO 1000 GALLONS PER HOUR



Designed for operation with either gas, oil or both with natural or forced draft. They can be depended on for maximum combustion efficiency.

ENCO Interchangeable Oil-Burners can be changed instantly to operate by either steam or mechanical pressure atomizing over a wide capacity range.

ENCO Oil Atomizers are applied to various types of standard pulverized-coal and gas-burner units cold starting or for full load operation when coal or gas is not available, or when oil is the more economical fuel.

Send for Bulletin OB-53 describing ENCO Gas and Oil Burners, also complete Pumping and Heating Units.

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BEECH-NUT LIFE SAVERS, INC.

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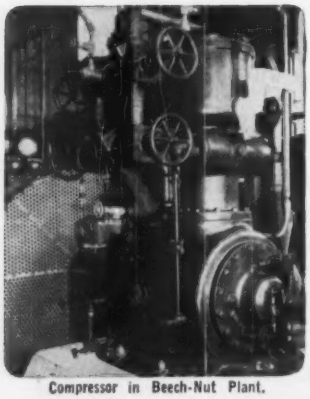
FRICK TRADE MARK

Refrigeration

One of two Plants at Canajoharie, N. Y.



Compressor in Beech-Nut Plant.

And use ten big Frick ammonia compressors, plus numerous condensers and coolers, in their famous plants at Canajoharie, N. Y.

For process work, air conditioning, and cold storage, Beech-Nut Life Savers find Frick Refrigeration an indispensable aid.

Recent installations made by Mollenberg-Betz Machine Co., Frick Sales-Representatives at Buffalo.

Let us aid you in applying modern refrigeration and air conditioning to your business. Estimates cheerfully furnished, without obligating you.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U. S. A.

More TECHNICAL BRIEFS

Begins on page 178

secondary steam will drive a single cylinder, 1800 rpm, 100,000 kw turbine-generator.

The reactor portion of the plant will be owned by the U.S. Government, and the turbine-generator portion by the Duquesne Light Co. Duquesne Light Co will operate the entire facility as an integral part of its generating system.

This paper describes the chief aspects of load control for Shippingport under both normal and emergency operating conditions. It concludes that a pressurized water thermal reactor with a negative temperature coefficient is basically self-regulating in the power range and lends itself favorably for use as a central station heat source from a control standpoint. The station will have about the same load response and maneuverability as a conventional fossil fuel plant operating on a utility system. Start-up and shut-down times compare favorably with fossil fuel type plants. The response of the nuclear heat source will not be a limiting factor for load changes which are beyond the design load limits of this plant. *AIEE paper, No. 57-1068.*

Lubrication

Solid film lubricants at high temperatures. *By E P Kingsbury, Massachusetts Institute of Technology.*

The behavior of several solid film lubricants has been experimentally established as a function of temperature. These films are formed of a suspension of lubricant particles (graphite, molybdenum disulfide) in a thermosetting resin baked onto a hard surface. The test consists of heating such a layer and continually observing the friction coefficient until failure.

Sliding conditions of high unit loading and low rubbing velocity were chosen to provide a comparison between the films. They were evaluated as to the highest temperature for which the friction coefficient remained low and subsequently as to the number of load cycles sustained at temperature before an abrupt increase in friction.

Results for all films were similar in that failure was caused by a breakdown of the binder rather than of graphite or MoS_2 and that the minimum friction coefficient (approximately 0.03) was observed just before the film failure at temperatures as high as 1200 F. Good endurance character-

Directions for ordering papers on page 246

COLOR-PORT

water level gage

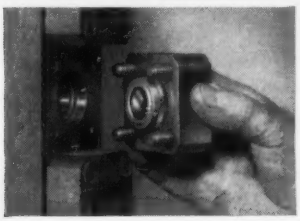
gives you . . . two-color readings . . . low maintenance . . . increased availability

You get a *triple advantage* with the Yarway COLOR-PORT boiler water level gage for pressures to 3000 psi.

Two-color readings are brilliant and clear. Water shows green; steam shows red. A full gage is all green and an empty gage all red.

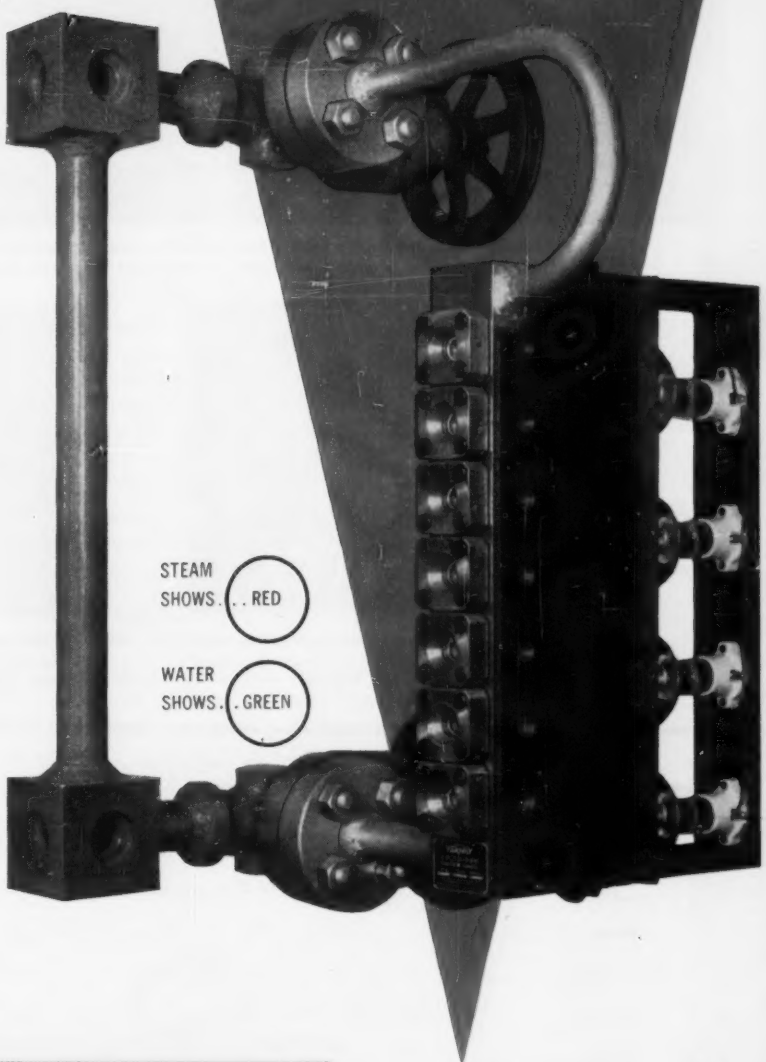
Low maintenance with individual cover-glass assemblies, each held solidly in place by four socket head cap screws. "Floating assembly" design applies safe, predetermined loads on glass ports, reducing thermal shocks, permitting faster warm-up.

Increased availability means longer service life. Cover glass assemblies can be *serviced in place*, easily and quickly.

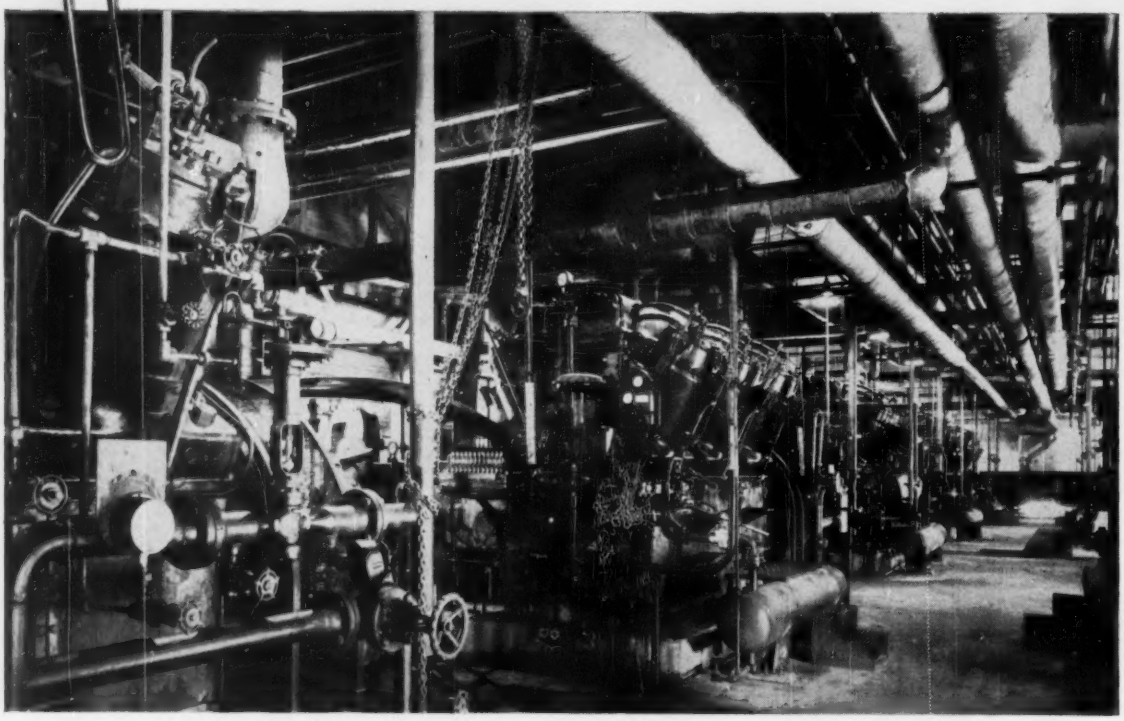


Yarway Bulletin WG-1814 describes the Color-Port Gage. Write for it.

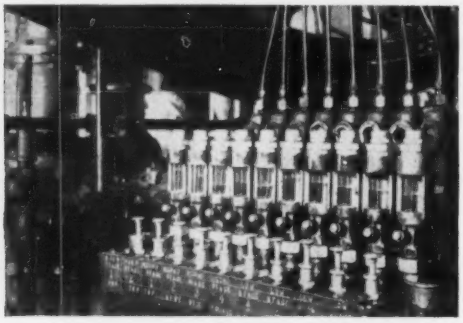
YARNALL-WARING COMPANY
100 Mermaid Avenue
Philadelphia 18, Pa.
Branch Offices in Principal Cities



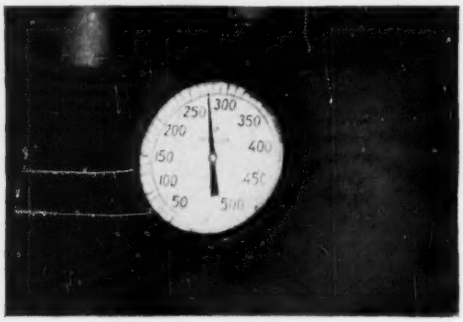
YARWAY COLOR-PORT . . . *a good way to specify high pressure water gages*



"... Cellulubes were tested for two years in four Cooper Bessemer Air Compressors. Cylinder wear was negligible. Deposits normally found in compressor auxiliaries and valves were reduced or eliminated."



"... A conventional lubricator will pump Cellulubes satisfactorily. No obnoxious vapors—does not present a personnel problem in terms of handling a toxic material."



"... No pressure surges nor evidence of fire in the air accumulator when Cellulubes are used. They are excellent lubricants, and also are effective as detergents."

CELANESE CORPORATION OF AMERICA, CHEMICAL DIVISION
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☐ Technical bulletin ☐ Sample of_____viscosity.

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Company_____

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City_____ Zone_____ State_____

Application I have in mind_____

From a trial file covering two years testing in Cooper Bessemer 3-stage air compressors

"NO PRESSURE SURGES...NO EVIDENCE OF FIRE... EXCELLENT LUBRICATION...WHEN FIRE-RESISTANT CELANESE CELLULUBES ARE USED!"

"Cellulube has now been in four of our Cooper Bessemer air compressors for approximately two years. The compressors were inspected during a recent Catalytic Reformer General Inspection. Cylinder liner wear was negligible, particularly when compared to the amount of wear we had experienced when previously using a synthetic lubricant. Cellulube, in addition to acting as a lubricant, is also effective as a detergent. Compressor cylinder air passages which had been heavily coated with carbonaceous materials and deposits laid down by the previous synthetic lubricant, are gradually being removed and the compressors again show the original factory finish. Deposits on valve cages and plates have been reduced and are no longer a problem.

"Cellulube does not present a personnel problem in terms of handling a toxic material. There are no obnoxious vapors from Cellulube. A conventional lubricator will pump Cellulube satisfactorily.

"There have been no pressure surges nor evidence of fire in the air accumulator.

"We believe this material is an excellent lubricant plus the fact that acting as a detergent the deposits normally found in compressor auxiliaries and valves have been reduced or eliminated."

These results are typical of what you can expect from Celanese Cellulubes. They have been developed to meet the pressing need for fire-resistant lubricants which virtually eliminate the problem of carbon deposits.

Celanese Cellulubes are available in 6 controlled viscosities: 90, 150, 220, 300, 550, 1000, S.U.S. @ 100° F. These straight phosphate esters provide excellent lubricity, are non-corrosive and non-reactive.

Celanese Cellulubes open new areas for in-plant protection against fire and explosion. Evaluate them in your own operation. Use coupon to request samples and technical data.

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Celanese Corporation of America, Chemical Division, 180 Madison Avenue, New York 16, N.Y.
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Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y.

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Work-Saving

POWER

for your pipe tools...anywhere!

Capacity:
⅛″ to 2″ pipe, conduit; to 12″ with geared tools; ¼″ to 2″ bolts.

Portable
RIDGID
200 Power Drive
with folding legs and tray

Cut, thread and ream easily when this very portable 200 turns pipe for your tools. Integral legs and handy built-in folding tray make it extra easy to carry and set up. Speed Chuck operates easily by hand, grips tight forward, reverse. Light, compact, rigid working stance—see all its advantages at your Supply House!

Every RIDGID Pipe Tool TESTED individually before shipment

The Ridge Tool Company, Elyria, Ohio, U.S.A.

RIDGID
Work-Saver Pipe Tools

More TECHNICAL BRIEFS

Begins on page 178

istics were observed at these high temperatures. *ASLE paper, No. 57LC-7.*

Boundary lubrication, wear-in and hydrodynamic behavior of bearings for liquid metals and other fluids. *By L F Coffin Jr, General Electric Research Laboratories.*

A variety of unusual bearing material combinations have been tested as a thrust bearing in NaK, xylene and spindle oil. The author found that certain of these combinations exhibit a phenomenon of extreme wear-in such that clearances in the micron range can be achieved by continuous operation of the bearing. At these small clearances the load-carrying capacity of the bearing becomes very high. The effect does not appear to depend on whether the fluid used has boundary lubricating properties or not.

There are certain requirements for these unusual conditions. These include extreme flatness of the harder bearing face and a low surface roughness of this face, careful temperature control, elimination of any radial motion of the bearing components relative to one another, and the use of simple bearing configurations such as flat pads and grooves.

There does not appear to be any consistent theory for selection of materials and fluids so as to obtain this behavior. Various mechanisms are described which could account for the wearing-in effect, but as yet there is no clear-cut understanding of the phenomenon. *ASLE paper, No. 57LC-6.*

Feedwater treatment

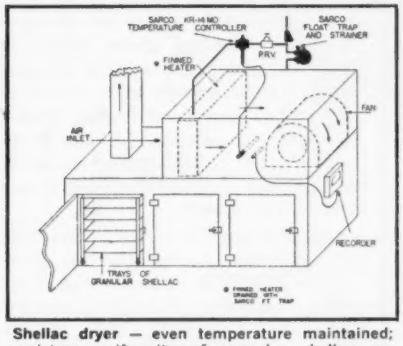
Conductivity versus sodium by flame spectrophotometer in steam purity studies. *By C A Bishof, J K Brown and H L Kahler, W H & L D Betz Co.*

Extensive laboratory and plant work indicates that sodium is extremely valuable in evaluating steam purity. It is far superior to conductivity and is sensitive enough to detect the solids and wetness of very high quality steam. Although 0.002 ppm is ample precision for average plant work, it can be extended to 0.00004 ppm.

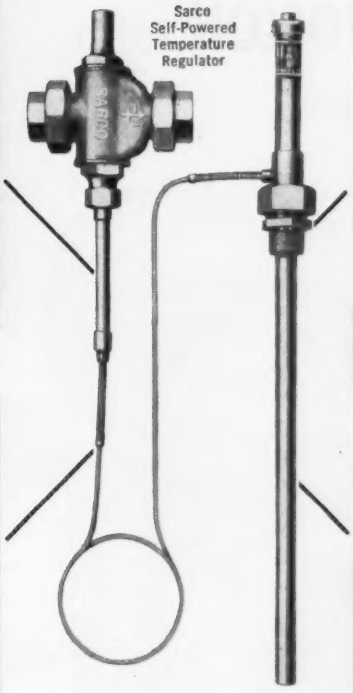
The plant studies described show results obtained when sodium test was applied: In steam containing high ammonia, to detect the solids content in steam at different levels of boiler water solids; to pick up the deleterious effect

Directions for ordering papers on page 246

Water storage tanks — Sarco self-powered temperature controls on service water storage tanks from twin heaters.



Shellac dryer — even temperature maintained; moisture uniformity of granular shellac accurately controlled — by Sarco self-powered temperature control.



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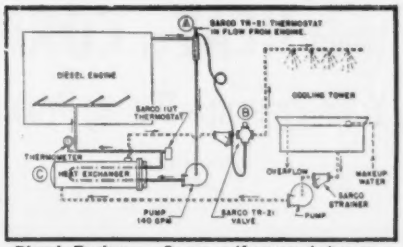
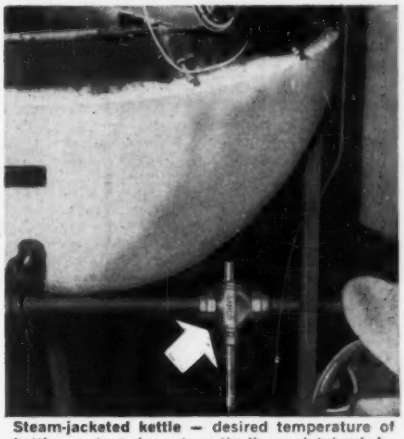


Diesel Engine — Sarco self-powered temperature controller used on diesel engine cooling system. Also ideal for compressors.



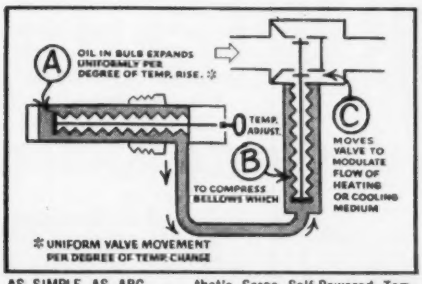
Steam-jacketed kettle — desired temperature of kettle content is automatically maintained by Sarco self-powered temperature control. Steam waste, uncertainty of manual control eliminated.

How to get Automatic Temp. Control that's simple, dependable, inexpensive

HERE'S the way to get rid of uncertain, time-wasting manual temperature control . . . *throughout* your plant. And without investing in complicated, costly temperature control equipment.

These SELF-POWERED Sarco controls are inexpensive, simple, dependable, accurate. They can be used for 85% of your jobs. ½" size costs only about $100!

Thousands of these Sarco controls are giving dependable, accurate service for firms such as Colgate-Palmolive Co., Sinclair Refining Co., Swift and Co.


A
OIL IN BULB EXPANDS UNIFORMLY PER DEGREE OF TEMP. RISE. *
TEMP. ADJUST.
B
TO COMPRESS BELLOWS WHICH
C
MOVES VALVE TO MODULATE FLOW OF HEATING OR COOLING MEDIUM
* UNIFORM VALVE MOVEMENT PER DEGREE OF TEMP. CHANGE

AS SIMPLE AS ABC . . . that's Sarco Self-Powered Temperature Control. A thermostat with capillary tubing and a valve . . . that's all there is to it!

SARCO SELF-POWERED TEMPERATURE CONTROLLERS
—need no power source

1. Self-Powered — no compressed air or electricity needed.
2. Easy to install — by any pipe-fitter.
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4. Simple — no gadgets that take a technician to read and repair.
5. Not affected by cross-ambient temperatures or elevation of the bulb.

Send for Bulletins: No. 620 — Self-powered Temperature Controls. No. 710 — Self-powered Cooling Controls. No. 1025 — Electric Indicating Temperature Controls. Sarco Company, Inc., 635 Madison Avenue, New York 22, N. Y. 2208-B

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Automatic Temperature Control

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Protect Pipe Joints with . . . W-S

FORGED STAINLESS or ALLOY STEEL FITTINGS

IN CORROSIVE SERVICE your pipe joints take a beating—fluid velocity and turbulence accelerate corrosion wherever there is a change in direction of flow.

AT HIGH TEMPERATURES structural changes in the metal can cause loss of strength and subsequent failure.

Those are good reasons for "playing it safe" in high pressure service with W-S Forged Stainless or Alloy Steel Pipe Fittings. W-S Stainless Fittings resist corrosion in a wide variety of process liquids and gases and high temperature steam. Available in Types 304, 316 and 304 L.

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W-S Forged Stainless and Alloy Steel Fittings can be obtained in Screw-End Type for 2,000 lb., 3,000 lb., and 6,000 lb. WOG service; Socket-Welding Type for Schedules 40, 80, 160 and Double-Extra Heavy Pipe. Send today for bulletin S-1-55.

Write to W-S Fittings Division, H. K. Porter Company, Inc., P.O. Box 95, Roselle, N. J.

H. K. PORTER COMPANY, INC.

W-S FITTINGS DIVISION

More TECHNICAL BRIEFS

Begins on page 178

of soot-blowing operation; and to pick and differentiate boilers equipped with primary and secondary purification.

The authors say that purity of steam from modern boilers with proper conditioning is far superior to that indicated by conductivity. *ASME paper No. 56-A-196.*

What do modern high-pressure boilers demand of feedwater? *By P F Baggish, Ebasco Services, Inc.*

Normal operating conditions of modern high-pressure plants for electrical generation, demand steam quality of highest possible purity. The ultimate level of steam quality may depend on any one of many contributing factors. These may include the character of the boiler water, boiler design, condenser leakage, and chemical treatment of feed and boiler waters.

All of these elements are important, but the prime consideration of steam quality lies in the characteristics of the boiler feedwater. Bear in mind that boiler feed and boiler waters are synonymous when referring to supercritical or "once-through" type boilers.

While control of all solids is important, the level of silica is of prime concern. The quality of feedwater and limits of boiler-water concentrations for boiler pressures up to and including the supercritical range are described. The use and operating experiences of evaporator and demineralizer installations for production of high-quality boiler feed are described. *ASME paper No. 56-A-192.*

TO OBTAIN COMPLETE TEXT

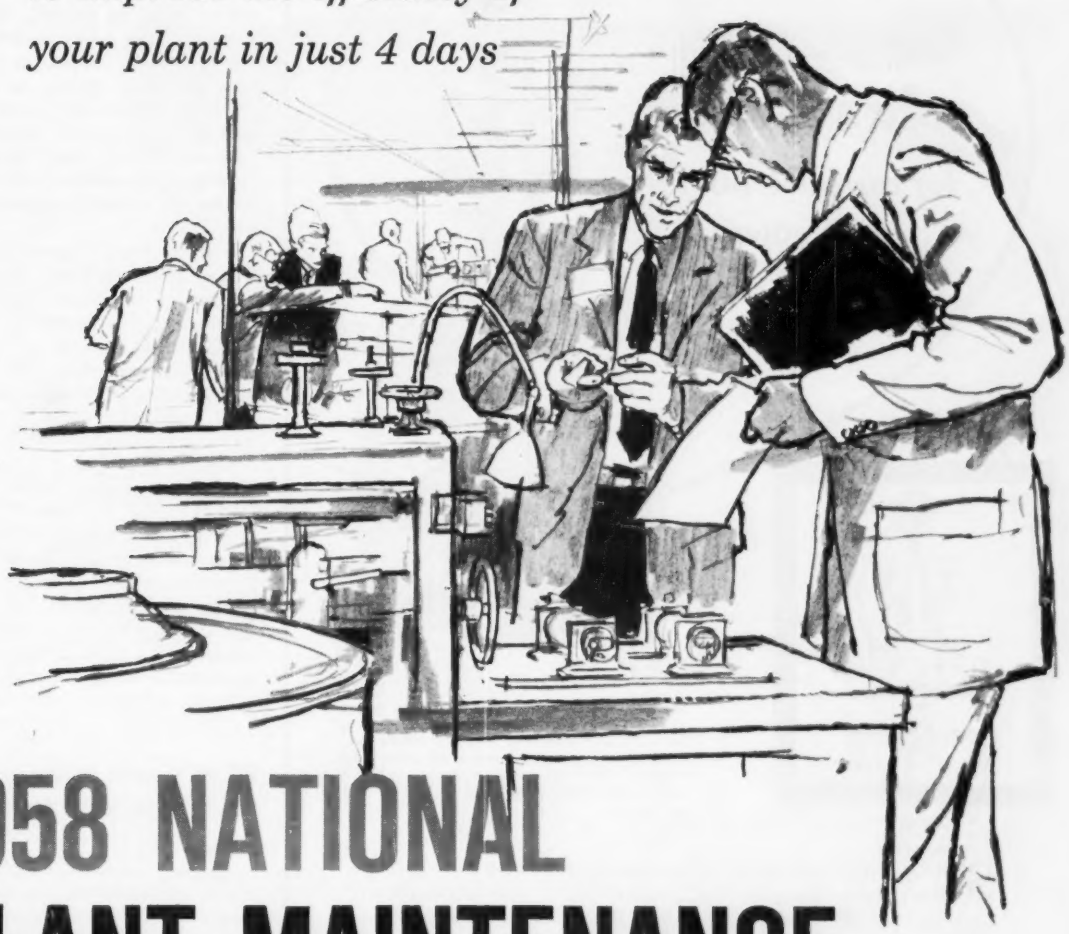
Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Lubrication Engineers, identified by initials ASLE. Information as to availability from ASLE, 84 E Randolph St, Chicago, Ill.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

Find hundreds of ways to improve the efficiency of your plant in just 4 days



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International Amphitheatre, Chicago
January 27 to 30, 1958

- **Over 400 manufacturers**
- **Over 120,000 square feet of exhibits of cost-cutting equipment and services**

For free registration cards for the show and information about the conference write:

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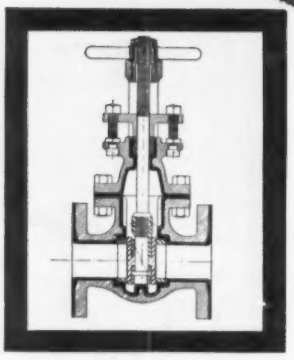
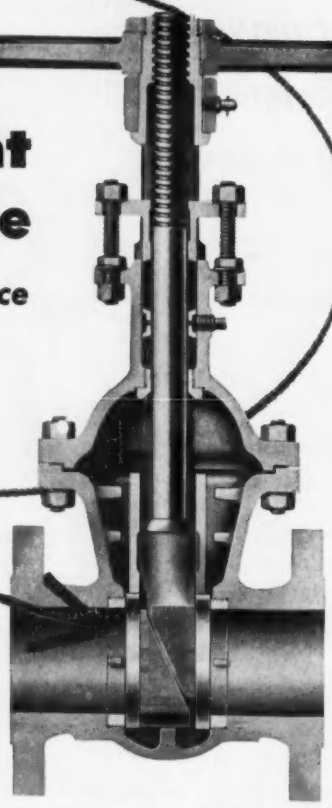
for corrosive service gate valves





Darling rubber-lined gate valves with special alloy working parts (left) are made for pressures to 150 pounds and temperatures to 150°. Other Darling gate valves come in a wide range of sizes, types and constructions for all normal and unusual services.

SURE Darling gate valves are available in the metals or special alloys needed for your particular service . . . and you ought to look into the hard rubber lined iron body type for possible savings. But beyond all that is where the real *plus-value* begins—the result of Darling's fully revolving double disc parallel seat principle!

This principle assures uniform wear distribution, automatic seating compensation, and avoidance of disc-to-seat galling. It means prolonged tight closure, much less maintenance and far less chance of process interruptions!

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ENGINEERING SERVICE: Darling offers unusual facilities for the development and manufacture of special valves for out-of-the-ordinary requirements. This special service is available to you at all times, without obligation.

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REPORTS from the FIELD

Begins on page 176

Load control *continued*

ule as often as desired. New system features three major developments: (1) generator output control using such solid-state devices as transistors, resulting in accurate control plus adherence to economic loading curves (2) rate limiting based on output and operating independently of the control system (3) accurate transistorized telemetering.

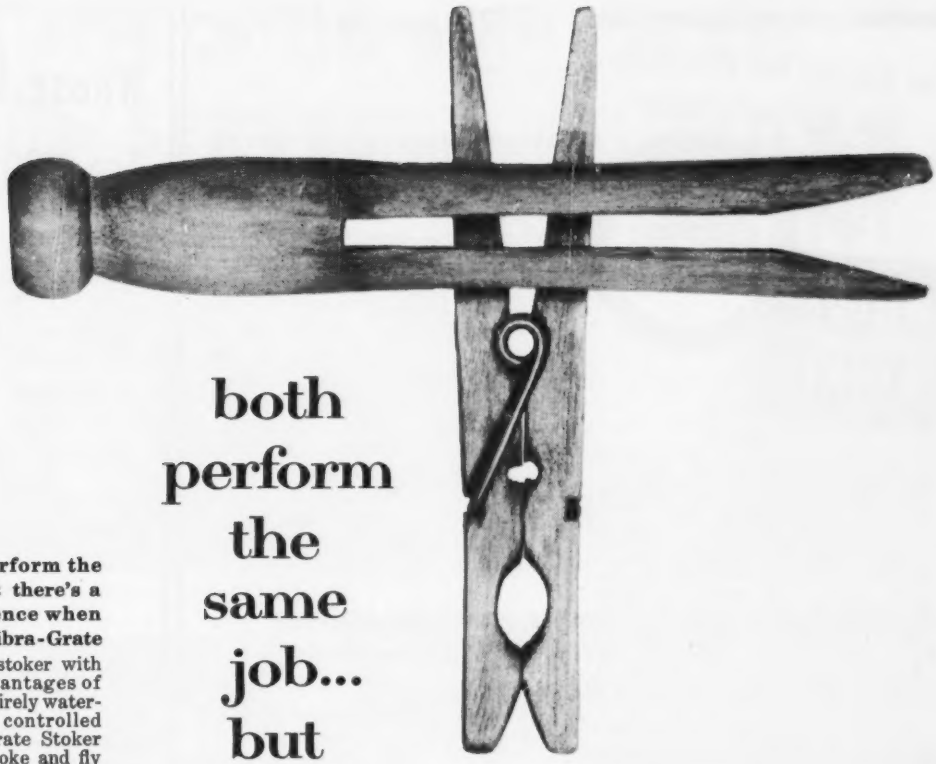
System was planned to provide fringe plus sustained (proportional plus reset) control. If system loads do not require fringe control, it can be eliminated by turning off power supply. As power-system growth and industrial load increases make fringe control necessary, it can be obtained by increasing voltage on power supply.

Control system is of command type; detects error signal, calls for proper load change and transmits intelligence to generators rapidly, to prevent load changes from getting dangerously large before correction is started. Control signal is transmitted to all units. Change in generation occurs simultaneously on all generators having same incremental costs, to minimize load change on any one unit.

IPE of Canada holds power show and convention

►RETURNING TO TORONTO, Ont. after four years' absence, Canada's Power Show, sponsored by the Institute of Power Engineers of Canada, hit its high-water mark this year. Held October 21-24 in the new Queen Elizabeth building in Toronto's International Exhibition Park, the show filled nearly 60,000 sq ft of space with 200 major exhibits. Power-plant equipment of all types was on display. Most of the exhibits were unusually large and arranged to demonstrate operation and control. One of the most outstanding was a package water-tube boiler by Dominion Bridge Co, weighing 44,000 lb and rated 12,000 lb of steam per hr at 200 psi.

Concurrent with the four-day exhibition, the Institute of Power Engineers of Canada held its 18th annual convention. This included technical and business sessions and daily luncheons all actively supported by major technical societies. A three-day Engineering-Management Seminar was top feature of the convention. The seminar program included principles and practices of effective human relations in business; business administration as-



both perform the same job... but there's a difference!

Steam plants all perform the same job, too . . . but there's a very decided difference when you choose AE's Vibra-Grate Stoker. For here's a stoker with everything . . . the advantages of others rolled into one entirely water-cooled, automatically controlled unit. The AE Vibra-Grate Stoker gives freedom from smoke and fly ash at both high and low ratings . . . eliminates need for dust collectors and cinder return systems . . . burns low-grade coals efficiently . . . is readily adaptable for burning gas or oil either singly or in combination with coal.

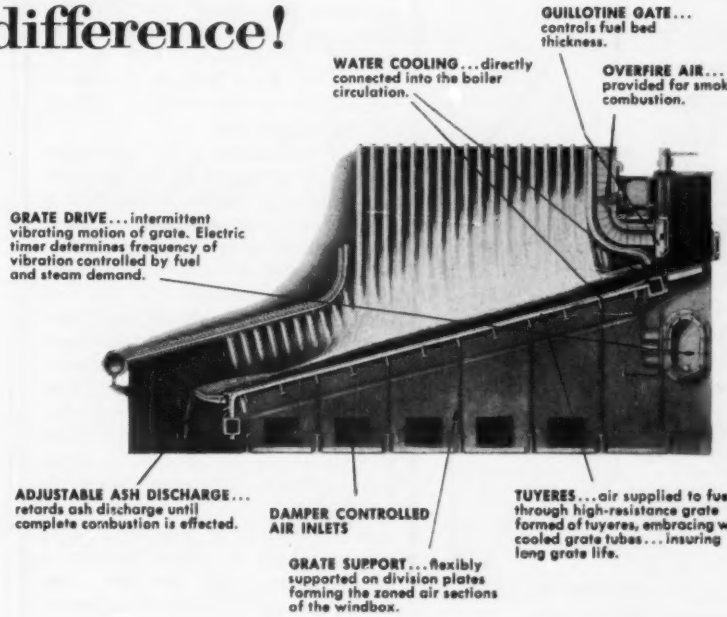
The Vibra-Grate Stoker feeds and moves the fuel automatically by intermittent vibrating motions, insuring even distribution and avoiding holes and light spots in the fuel bed. Its highly effective water-cooling system guarantees long grate life with proved maintenance of less than 2/10 cents per ton of coal burned.

The Vibra-Grate is years ahead in design efficiency, yet its over-all cost is low. If you're thinking of adding a new power plant or modernizing your present one, write today for details of the Vibra-Grate . . . you won't be disappointed.

Other outstanding stokers made by American Engineering Company are:

TAYLOR STOKER: an underfeed stoker for power requirements ranging from 20,000 to 500,000 pounds.

PERFECT SPREAD STOKER: a spreader stoker with spiral-type rotors and continuous chain feeders for both lateral and longitudinal coal distribution.


GUILLOTINE GATE... controls fuel bed thickness.
WATER COOLING... directly connected into the boiler circulation.
OVERFIRE AIR... provided for smokeless combustion.
GRATE DRIVE... intermittent vibrating motion of grate. Electric timer determines frequency of vibration controlled by fuel and steam demand.
ADJUSTABLE ASH DISCHARGE... retards ash discharge until complete combustion is effected.
DAMPER CONTROLLED AIR INLETS
GRATE SUPPORT... flexibly supported on division plates forming the zoned air sections of the windbox.
TUYERES... air supplied to fuel bed through high-resistance grate formed of tuyeres, embracing water-cooled grate tubes... insuring long grate life.

AMERICAN ENGINEERING COMPANY

Wheatsheaf Lane and Sepviva Street S-100
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Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q., Bawden Industries Ltd., Toronto, Ont.

The Greater the Pressure... the Tighter It Holds!

There's still nothing simpler or more efficient in power line service than this Wilcox Self-Sealing Gasket which has served industry so well over the years. The U-shaped metal outer cover is packed with a resilient filling (usually rubber or asbestos). Pressure exerted on this elastic filling forces it into the cover, putting force against the adjacent flange surfaces. Thus, internal pressure that tends to blow ordinary gaskets makes the Wilcox Gasket tighter in the joint. Available with covers of copper, lead, tin, aluminum, monel, stainless steel, etc. in all sizes—standard or special.

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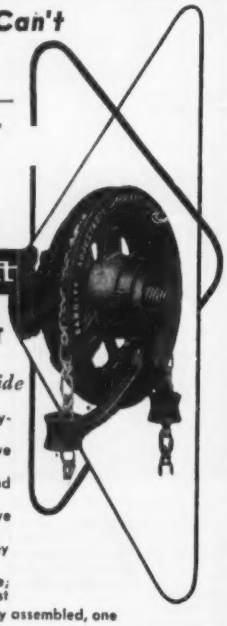
Insurance Can't

PREVENT ACCIDENTS— A BABBITT SPROCKET RIM CAN!



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Adjustable
SPROCKET RIM
with Chain Guide

- Simplifies pipe lay-out
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- Easy to follow instructions with each unit
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- Write for new descriptive catalog sheet and prices

Babbitt STEAM SPECIALTY CO.
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REPORTS from the FIELD

Begins on page 176

pects of the engineer's job; the art of leadership. The six sessions of the seminar were highly successful with nearly 100% attendance. In addition to the daily luncheon meetings, social functions included three banquets at the Royal York Hotel.

Institute of Power Engineers' senior officers elected for 1958 are: National president: Thomas C Bishop, chief engineer, Cities Heating Ltd, London, Ont.; 1st vice-president: Charles T Johnson, chief engineer, Merck Ltd, Valleyfield, Que.; 2nd vice-president: Geoff Andrews, chief engineer, Canadian Car and Foundry Ltd, Fort William, Ont.; General Secretary: James Y Smith, chief engineer, McColl-Frontenac Oil Ltd, Toronto, Ont.

Mouth-to-mouth breathing best artificial respiration

► ARTIFICAL RESPIRATION by means of mouth-to-mouth breathing, a system in use since Biblical days, was recommended at a safety symposium during the Fall General Meeting of the AIEE. Mouth-to-mouth insufflation was termed a superior means of resuscitation in two technical papers, "A comparison of mouth-to-mouth and manual artificial respiration techniques," and "The principles and practice of emergency mechanical resuscitation," both by Dr Charles W Frye and Dr Archer S Gordon, of the University of Illinois College of Medicine.

These conclusions are of particular interest to personnel in the electrical field, who are constantly exposed to shock. For pole-top resuscitation, where some method of artificial respiration must be started at once, mouth-to-mouth and push-pull methods give the best ventilation, and should be used until a mechanical resuscitator with mask extension can be taken up the pole, or the victim can be lowered to the ground.

The doctors stressed that time was of the essence in any resuscitation. Month-to-month resuscitation proves superior in tests because it leaves the hands free to insure unobstructed passage to the lungs by inserting a finger into the mouth to prevent obstruction by the tongue, with the other hand free to massage the stomach to prevent its being inflated by air.

* * *

Use of mechanical - resuscitation equipment was second topic discussed at symposium. Cost of equipment may be justified if it does no more than

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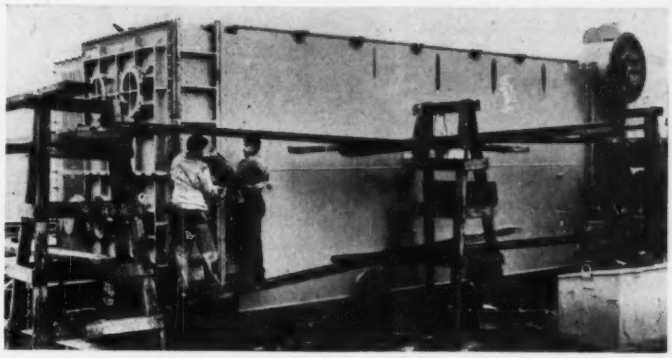
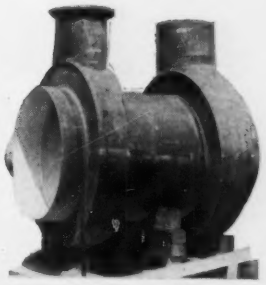
JUST A FEW OF THE MANY WAYS CONSECO SERVES *users of* TUBULAR EQUIPMENT..

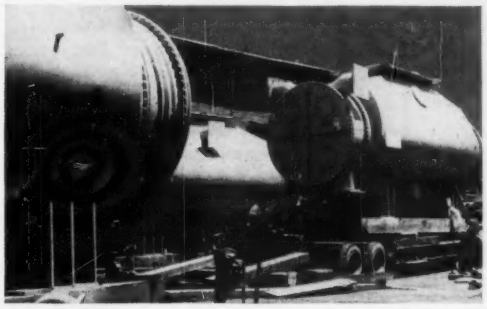


A 45,000 sq. ft. Condenser furnished to Puerto Rico Water Resources Authority.

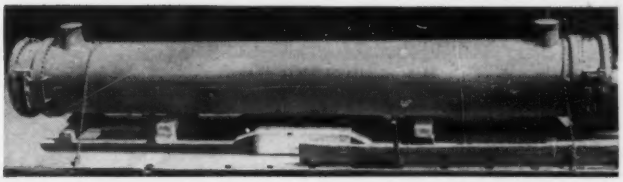


RIGHT:

SPECIAL HEAT EXCHANGER with aluminum sprayed interior and calorized tubes, "custom-built" by CONSECO for GENERAL CHEMICAL COMPANY.



Showing three CONSECO Condensers (built simultaneously) being prepared for shipment to the Far East, for Steam Power Plant use. Presently under construction by CONSECO is a 45,000 sq. ft. Condenser for the City of New York, also a 50,000 sq. ft. unit for Dairyland Power Cooperative.



This CONSECO-built Condensate Cooler is one of four shipped to "PUBLIC SERVICE of NEW JERSEY." We have 6 more like it under construction for Memphis, Tennessee.

TODAY it may be building three Condensers, simultaneously, for overseas . . . or a Heat Exchanger to meet special difficult conditions . . . or Condensate Coolers in quantity for big Utilities . . . or a rush retubing job . . . no matter what the work, CONSECO experience and facilities will handle it quickly, dependably, economically.

SEND FOR THIS CONSECO BULLETIN ON STEAM CONDENSERS . . . CUT YOUR POWER COSTS.

For more data consult Chemical Engineering Catalog pages 559-562

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All Evaporating, Feedwater Heating, Condensing, Air Removal and Condensate Cooling Equipment required in any Thermal Power Generating Plant.

Condensers • Evaporators • Deaerators
Converters • Feedwater Heaters
Steam Jet Air Ejectors

Big or small, CONSECO Equipment is the choice of Engineers who have well-placed confidence in CONSECO's 30 years experienced engineering, sound design, dependable manufacturing and better performance.

CONDENSER SERVICE & ENGINEERING CO., INC., has designed, built and installed hundreds of CONDENSERS of all types; single and multi-pass; divided and non-divided flow; for engines and turbines; both power plant and water works types.

To well known design data and to a complete understanding of maintenance and operation, CONSECO adds features to simplify and economize them.

Our extensive maintenance and repair experience on CONDENSERS OF ALL TYPES contributes much to the simplification and performance of CONSECO units.

CONSECO is equipped and thoroughly qualified by 30 years experience to repair, re-tube or re-build any type of tubular equipment, our own or any other manufacture. Extensive facilities and personnel handle emergency assignments on the job or in our own shops.

A CONSECO re-designed heat exchanger is usually a better product than the original equipment because it benefits, during repairs, from our familiarity with all types of heat exchangers and of features that help achieve longer, trouble-free, more efficient operation.

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Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

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A 6000#/24 hr. capacity W&T chlorinator is used on the central cooling water system at Marcus Hook, Penna. refinery of Sinclair Refining Company.

W & T CHLORINATION . . .

the economical way to prevent slime in cooling waters

Water used for cooling operations at the Marcus Hook refinery of Sinclair Refining Company is chlorinated to prevent slimes from fouling plant units and lowering cooling efficiency.

Chlorination of the system is accomplished by one **W&T** chlorinator operated from a program control panel. The control automatically starts and stops chlorination in accordance with a preselected schedule. Slime growths are eliminated in the cooling units without the need for continuous treatment.

For information about **W&T** chlorination for slime elimination write for Bulletin CD-43.

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Accuracy: 1/300 of full scale
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REPORTS from the FIELD

Begins on page 176

improve electrical crews' awareness of life-saving possibilities, according to T M C Martin, of the University of California Berkeley. In his paper, "The adjunctive use of mechanical resuscitation in electrical contact accidents," Martin stated that manual artificial-respiration techniques are not always adequate.

When equipment is provided it is up to the company to stress safety training for all. Equipment should be located where "hot-line" work is under way before accidents have a chance to occur, Martin concluded.

Calendar of Events

Dec 9-10—Institute of Metals, Metals Physics Committee, symposium on vacancies and other point defects in metals and alloys. Harwell, England. Details from the Secretary, Institute of Metals, 17 Belgrave Square, London, S.W. 1.

Dec 9-13 — National Association of Corrosion Engineers, in conjunction with University of Illinois biennial Short Course on Cathodic Protection. Details from NACE, 1061 M&M Bldg, Houston 2, Texas.

Jan 27-29—American Society of Heating and Air-Conditioning Engineers, Inc, annual meeting. Pittsburgh, Pa. Details from ASHAE, 62 Worth St, New York, N. Y.

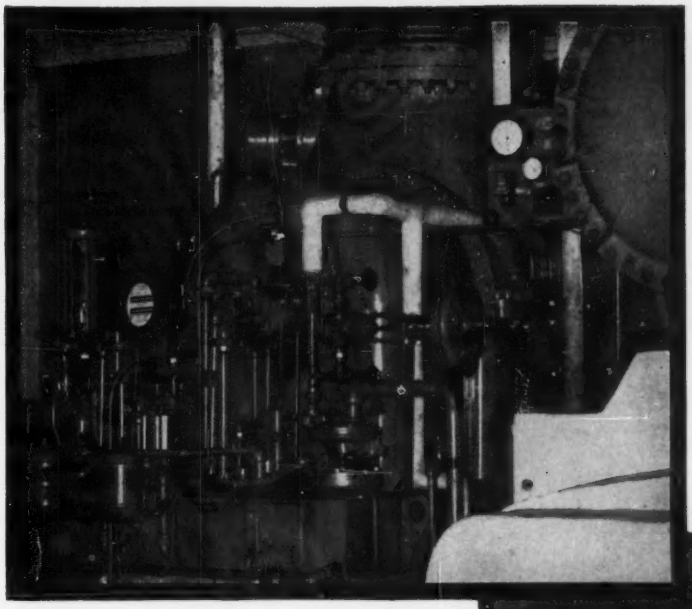
Jan 27-30—Plant Maintenance & Engineering Show. International Amphitheatre, Chicago, Ill. Details from Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Feb 3-4—Instrument Society of America National Conference on progress and trends in chemical and petroleum instrumentation. Wilmington, Del. Details from H S Kindler, Instrument Society of America, 313 Sixth Ave, Pittsburgh 22, Pa.

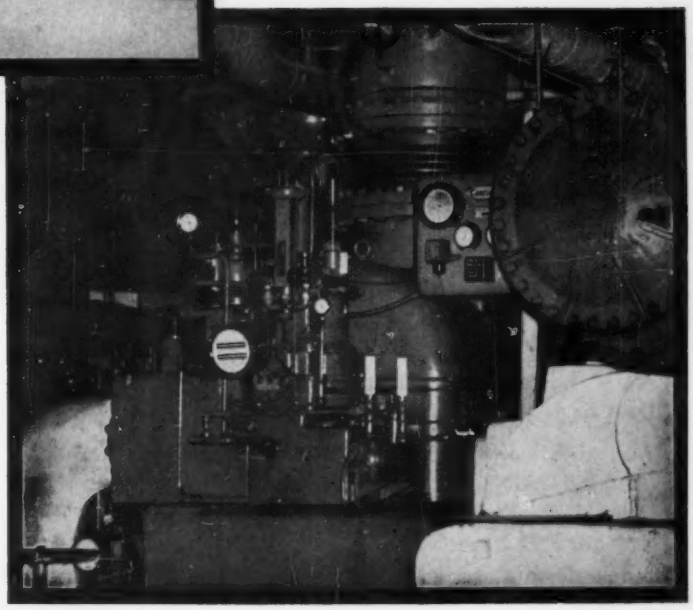
Feb 9-15—National Electrical Week. Purpose: "to enhance public appreciation of electricity and the contributions of the electrical industry to the nation's progress and economy." Details from National Electrical Week Committee, 290 Madison Ave, New York 17, N. Y.

Feb 24-28 — American Institute of Mining, Metallurgical and Petroleum Engineers Inc, annual meeting. Jung Hotel, New Orleans, La. Details: AIME, 29 W 39th St, New York 18, N. Y.

Feb 26-28—American Society of Civil Engineers, national convention. Chicago, Ill. Details from ASCE, 29 W 39th St. New York 18, N. Y.



1948—For air conditioning drive B. Altman & Co. installed a Murray low pressure turbine providing 633 HP at 5010 RPM.



1950—Again B. Altman & Co. selected Murray to drive another air conditioning unit with a 905 HP, 3880 RPM low pressure turbine.

ALTMAN'S SCAVENGES LOW PRESSURE STEAM FOR AIR CONDITIONING DRIVE

B. Altman & Co. in New York City are utilizing low pressure steam to power the air conditioning of their large department store at 34th Street and Fifth Avenue. Economical Murray turbines operating on exhaust steam at only 2# gauge pressure provide the smooth dependable power for the store's two centrifugal compressors. Your low pressure steam can be utilized just as effectively to drive any type of machine. Murray's low pressure turbines are developing as much as 2200 HP in a single turbine and of course Murray's long experience assures you af an added plus value of service and long life.

Consult your local Murray representative who will be pleased to show you ways of utilizing your low pressure steam. MURRAY IRON WORKS COMPANY, Burlington, Iowa.

★★ **Murray Turbines** ★★

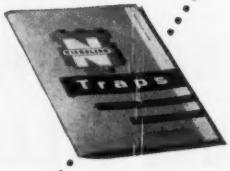
stop condensate backup

Nicholson steam traps discharge condensate and air from steam lines and equipment *faster* than any other trap of comparable size . . . help you make full use of your steam dollar. The reason—the effective use of a large orifice. A ½" Nicholson trap has a greater discharge capacity than most 1¼" traps . . . and costs less, too!

And that's not all. With just one thermostatically-operated moving part, there's nothing to get out of order, nothing to go wrong. Nicholson means continuous and low-cost operation of your steam-using equipment . . . no downtime from trap failure.

- **powerful valve action . . . no mechanical linkages to cause trouble.**
- **small and lightweight . . . easy to pipe and support.**
- **each unit steam-tested before shipment.**

So, to get a trap that discharges faster, saves money, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. *Sales and Engineering offices in 98 principal cities.*

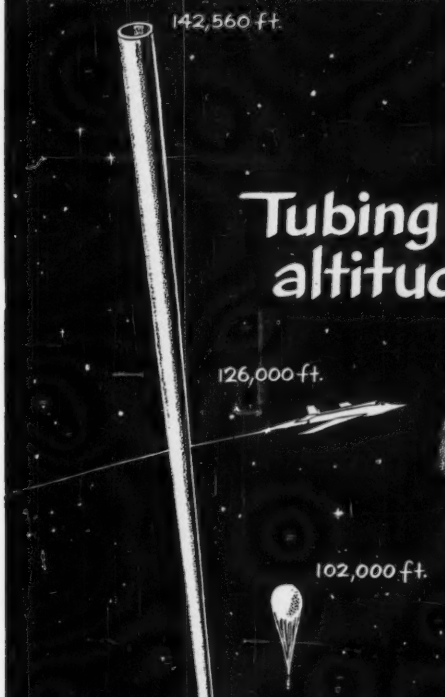


Write for Bulletin 1055

NICHOLSON
of Wilkes-Barre

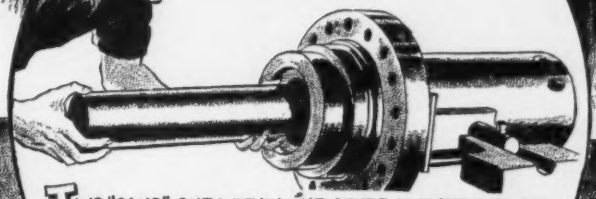
POWER POINTERS

Tubing enough to top U.S.A.F. altitude record by 3.1 miles



END TO END, MONEL* NICKEL-COPPER ALLOY TUBES IN AN EASTERN POWER COMPANY'S TWO NEW FEEDWATER HEATERS WOULD REACH 27 MILES ABOVE SEA LEVEL—OVER 3 MILES HIGHER THAN THE UNOFFICIAL ALTITUDE RECORD FOR POWERED AIRCRAFT...7 MILES ABOVE THE NEW RECORD FOR BALLOONS. THE HIGH STRENGTH OF CORROSION-RESISTING MONEL ALLOY PERMITS USE OF RELATIVELY LIGHT 17-GAUGE TUBING IN HANDLING FEEDWATER AT PRESSURES OVER 2000 PSI AND BLEED STEAM TEMPERATURES UP TO 820°F...SPEEDS HEAT TRANSFER.

Secret of seal-less pump: the metal that acts like air



TWO "CANS", ONE WITHIN THE OTHER, ISOLATE STATOR AND ROTOR OF THIS LEAK-PROOF SEAL-LESS PUMP FROM CIRCULATING FLUIDS. "CANS" ARE MADE OF INCONEL* NICKEL-CHROMIUM ALLOY. MAGNETICALLY, INCONEL ALLOY BEHAVES LIKE THE AIR GAP IN AN ORDINARY ELECTRIC MOTOR, CREATES NO MEASURABLE INTERFERENCE WITH MAGNETIC FLUX...HAS NO EFFECT ON MOTOR EFFICIENCY.

Trumpet valve cycles up to 8 times per second in "Flight of the Bumble Bee"

FIRST COUSINS TO INDUSTRIAL COMPRESSED AIR VALVES, TRUMPET VALVES MUST RESPOND TO HIGH SPEED FINGERING. TO PREVENT STICKING, WEAR AND CORROSION—ENEMIES OF TRUMPET AND INDUSTRIAL VALVES ALIKE—A FAMOUS MANUFACTURER MAKES VALVE PISTONS FOR HIS TRUMPETS OF MONEL* NICKEL-COPPER ALLOY. CORROSION-AND-WEAR RESISTANT MONEL ALLOY IS READILY MACHINED, BRAZABLE AND TAKES A HIGHLY POLISHED FINISH.

STUMPED BY A METAL PROBLEM?

PERHAPS GETTING TOGETHER WITH INCO'S MECHANICAL ENGINEERING SECTION WILL HELP YOU COME UP WITH AN ANSWER. FOR A PRELIMINARY BRIEFING, WRITE

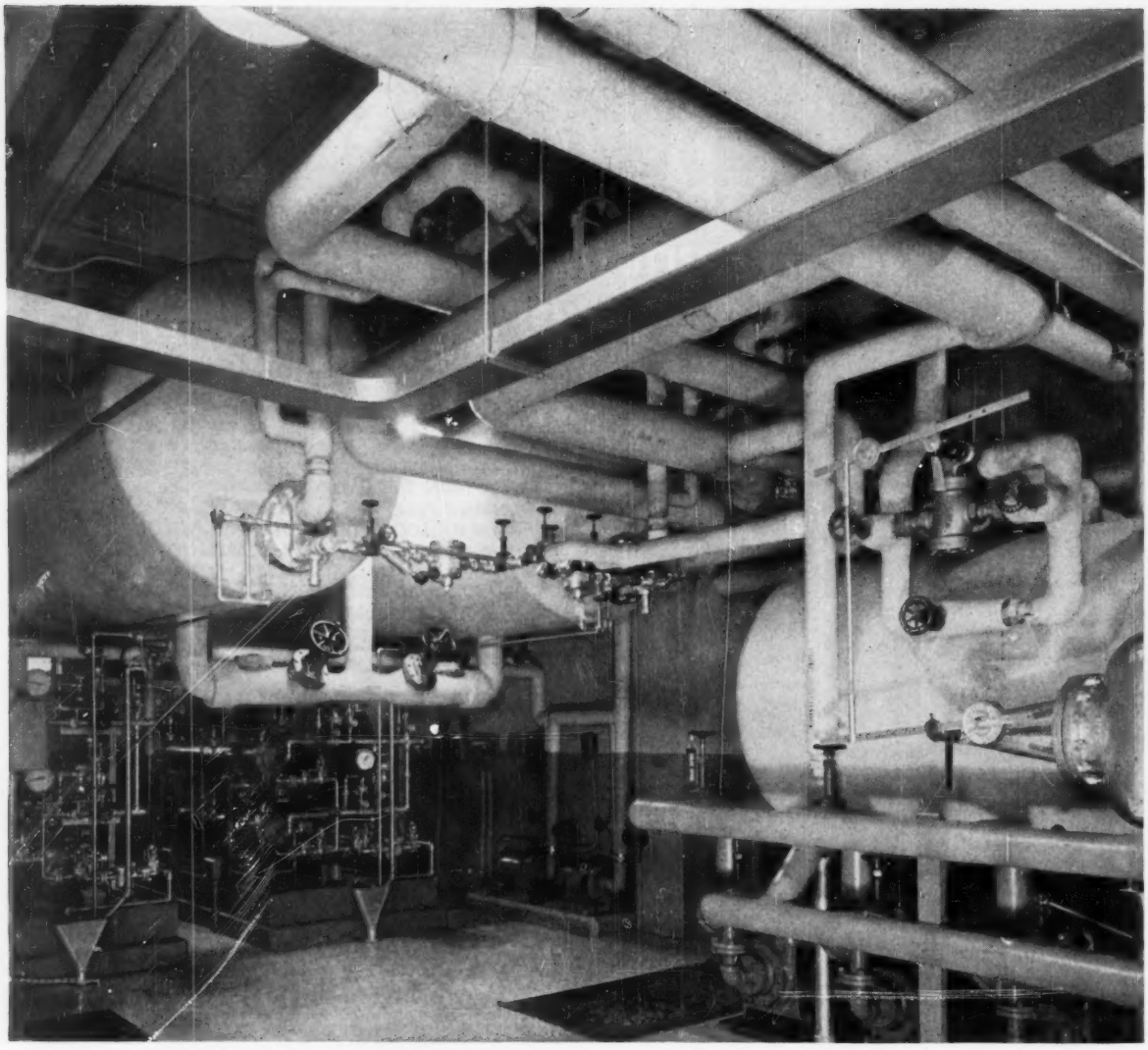
Department PO

FOR INCO BULLETINS COVERING ENGINEERING PROPERTIES OF INCONEL* AND INCONEL 'X'* ALLOYS AND MONEL* AND 'K' MONEL* ALLOYS.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

*Registered trademark



K&M HIGH-PRESSURE INSULATIONS WITHSTAND VIBRATION AND TEMPERATURE CHANGES!

Minimize Fuel Costs As Long As The Equipment Lasts!

You get more heat from every fuel dollar. With K&M High-Pressure Insulation, your fuel costs remain low . . . your process control more precise. Even severe operating conditions can't interfere with its insulation efficiency.

K&M High-Pressure Insulations meet every need. For temperatures up to 1900°F., use K&M Hy-Temp Combination—diatomaceous silica overlaid with K&M "Featherweight" 85% Magnesia. Staggered joints prevent heat loss through expansion-caused openings. For temperatures up to 1350°F., use K&M Kaytherm—hydrous calcium silicate bonded with asbestos fibers—important for power and petroleum applications. For temperatures up to 600°F., use K&M "Featherweight" 85% Magnesia—a basic carbonate of magnesia mixed with asbestos fibers. K&M High-Pressure Insulations come in a variety of sizes and thicknesses . . . in pipe and block insulation.

Write today to us for more information.

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

In Canada: Atlas Asbestos Company, Ltd., Montreal, Toronto, Winnipeg, Edmonton, Vancouver

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.

2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.

3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.

4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.

5. Sleeves carried on bearing rings, located on *transverse center line of hub spline faces* (the load-carrying surfaces) . . . no crank action, no vibration.

6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

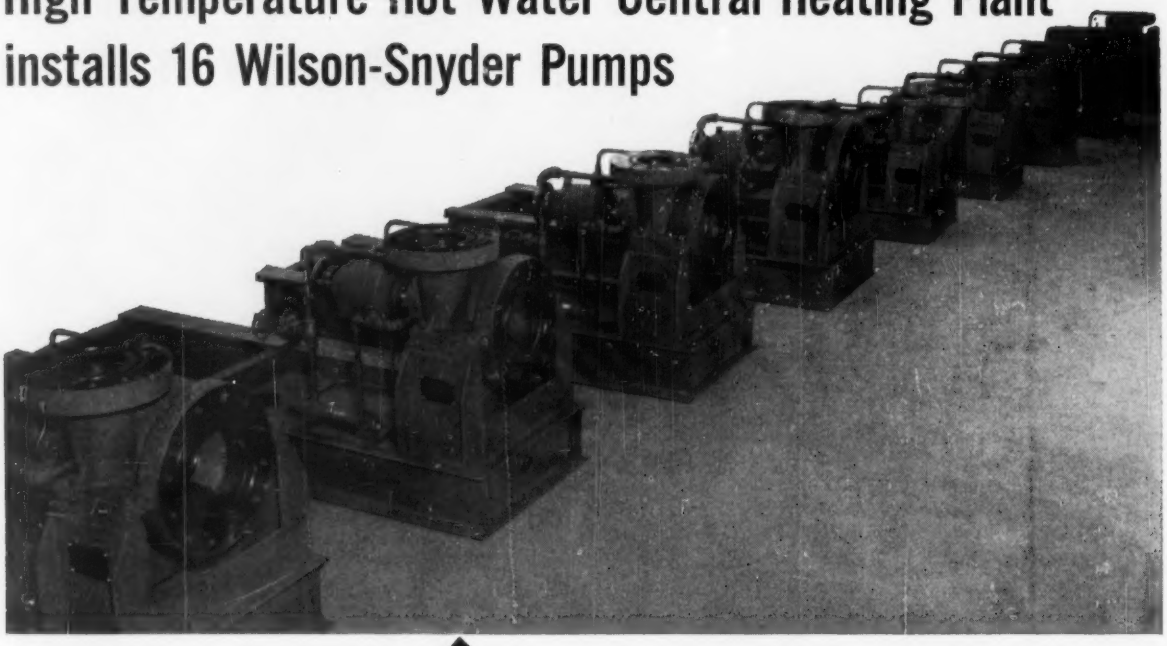
For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3312 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
Engineered Products Sold with Service.

High Temperature Hot Water Central Heating Plant installs 16 Wilson-Snyder Pumps

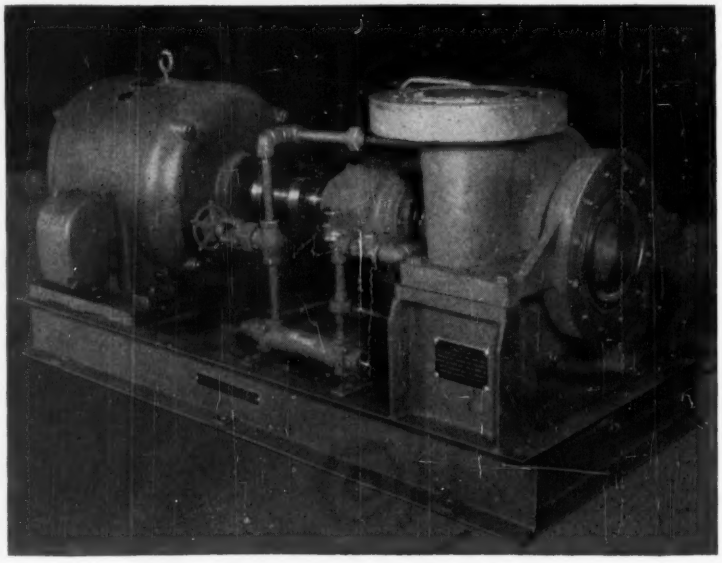


16 Wilson-Snyder Centrifugal Pumps are now being installed in central heating plants for the service and academic areas of the new Air Force Academy at Colorado Springs, Colo.

In this relatively new field of application, there are now in service throughout the country over 200 Wilson-Snyder Centrifugal Pumps specifically designed for use under high temperatures (400°—500° F.) and high suction and discharge pressures. The complete line of Wilson-Snyder Pumps for this service includes 22 sizes for capacities up to 2000 gpm.

Complete information about Wilson-Snyder Pumps for central heating—as well as the complete line of Wilson-Snyder Centrifugal and Reciprocating Pumps—will be furnished on request.

Here are 9 of 16 pumps (without drivers) before shipment to the new Air Force Academy. These are heavy-duty, center-line-supported, single-stage pumps, with vertically split cases. One basic design in all sizes minimizes parts inventory requirements on the job. Single-stage pumps can be furnished with end or top suction connections. Only one water-jacketed stuffing box for conventional packing or mechanical seal is employed, and it is subjected only to suction pressure. In and out connections to the lantern ring are provided for sealing, flushing, recirculating, or bleeding-off pressure. Every pump is carefully tested before shipment.



End-suction, top-discharge unit equipped with mechanical seal. Pumped liquid is circulated through heat exchanger and introduced at seal faces for cooling and flushing. Note that pump and integral suction flange is firmly supported at center-line to allow free expansion in all directions and to transmit pipe strains directly to foundation. Spacer-type coupling permits easy dismantling of pump without disturbing case, piping or driver alignment.

WILSON-SNYDER WORKS—Braddock, Pa., Oil Well Supply Division, United States Steel Corporation

WILSON-SNYDER PUMPS USS

UNITED STATES STEEL

Being interviewed is W. C. Dunn, Supervisor of Industrial Laboratories

"We've been waiting 21 years for this battery to wear out"

At the Exide Laboratories—**Reporter:** Has this battery been on test all that time, Mr. Dunn?

Dunn: Yes, it's been subjected to a continuous float life test typical of the kind of use it would get in most applications. And you can see for yourself just how little sediment there is on the bottom of the jar.

Reporter: What does that indicate?

Dunn: It means that most of the active material is still locked in the spiral lead buttons unique with Exide-Manchex Batteries.

Reporter: Do today's Exide-Manchex Batteries have the same long life potential?

Dunn: Even better. Because the batteries made today incorporate significant improvements in materials and construction that assure even greater length of service and better performance than these batteries were ever capable of before.

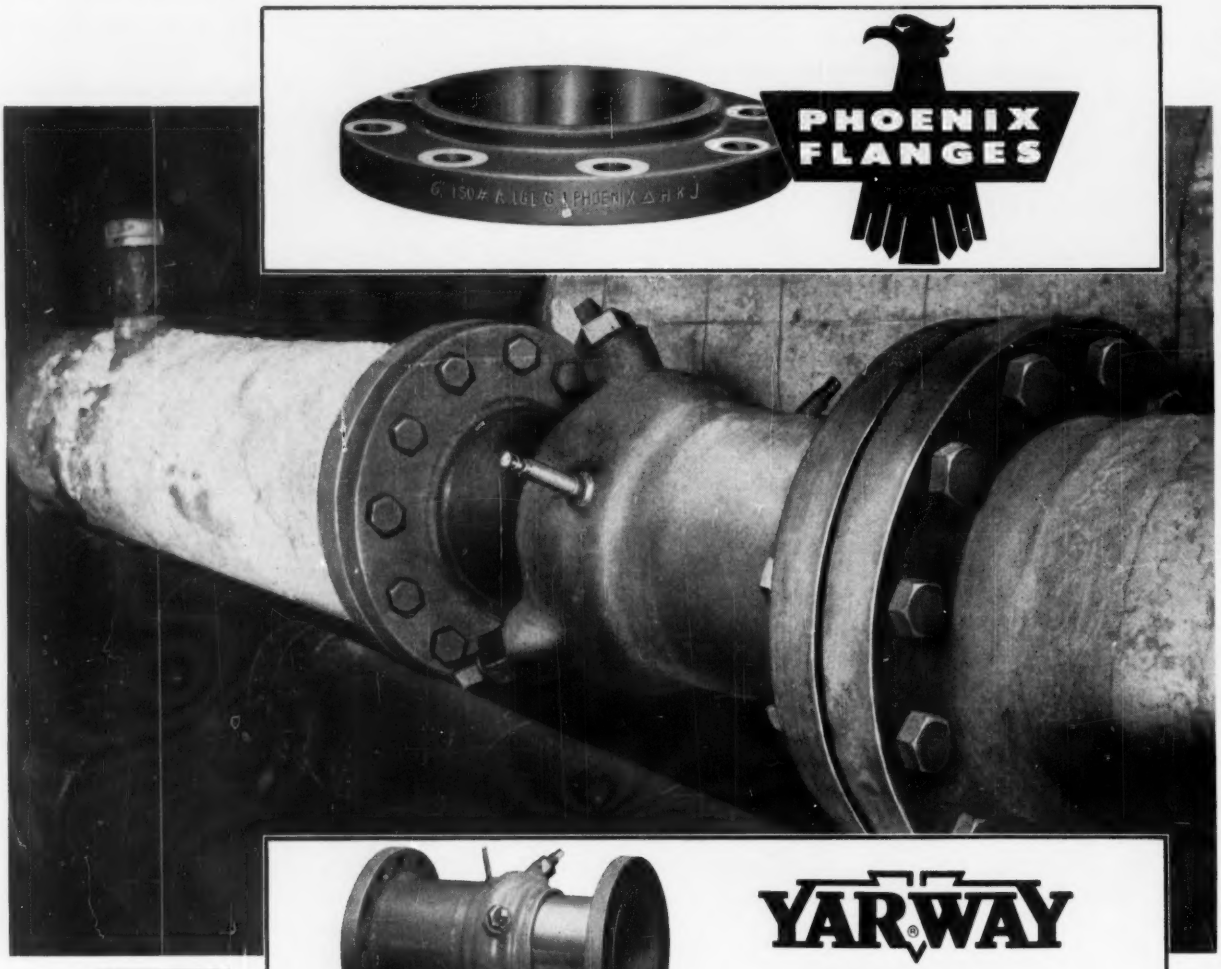
Reporter: What do these advantages mean to battery users?

Dunn: Greater economy and more dependability—the two qualities that have made Exide-Manchex Batteries world famous for years.

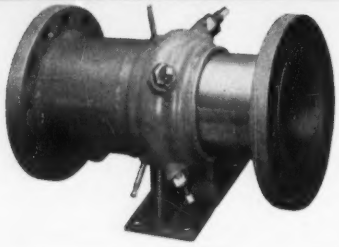
Note to battery users: Whenever you order batteries for float or cycle service in stationary applications, be sure to specify Exide-Manchex. Write for detailed bulletin. Exide Industrial Division, The Electric Storage Battery Company, Phila. 2, Pa.

THE ELECTRIC STORAGE BATTERY COMPANY Exide®

TWO QUALITY PRODUCTS TEAMED FOR AN EFFICIENT INSTALLATION



Write for free 36-page pocket reference booklet



YARWAY

GUN-PAKT EXPANSION JOINTS

Because there is no need to shut down for repacking, the Yarway Gun-Pakt is one of the most popular expansion joints used in modern steam distribution lines. The Yarway joint is built for long service, with never any danger of metal fatigue or failure.

There must be no failure at flanged connections, either. That's why Yarnall-Waring Co. uses Phoenix forged-steel flanges on Gun-Pakt expansion joints.

Like Yarnall-Waring, you, too, will find that *you can't buy better flanges*. May we demonstrate the advantages of Phoenix service?

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings

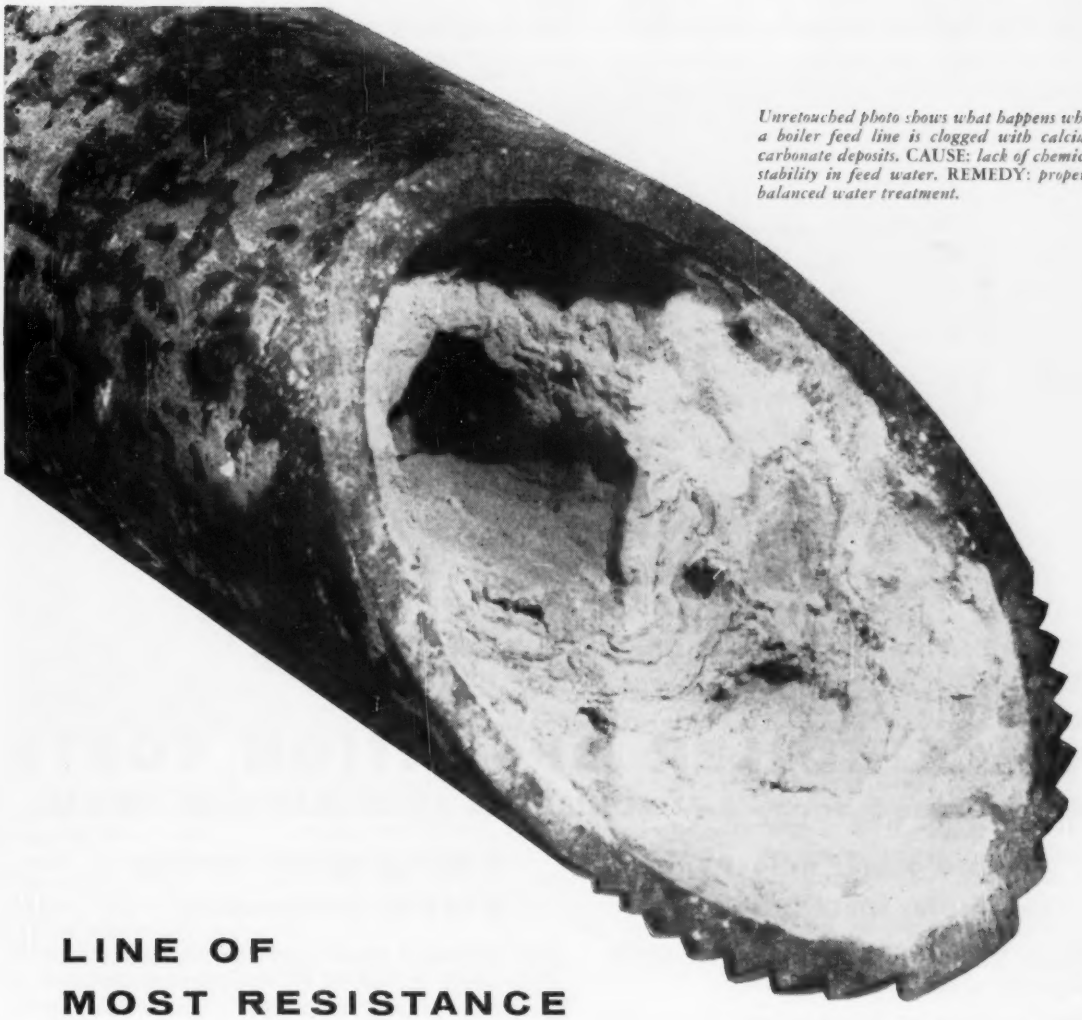
PHOENIX

FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. · JOLIET, ILL. · FOUNDED 1882

Integrated Manufacturing Facilities: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, RUBBER PRODUCTS DIVISION



Unretouched photo shows what happens when a boiler feed line is clogged with calcium carbonate deposits. CAUSE: *lack of chemical stability in feed water.* REMEDY: *properly balanced water treatment.*

LINE OF MOST RESISTANCE

A heavy build-up of scale, like that shown in the illustration, will gradually reduce the effective diameter of feed line piping, and will result in seriously restricted carrying capacity.

The line must be shut down for maintenance or replacement, causing expensive down time in the plant. Proper water conditioning will prevent this unnecessary loss. This is but one of the many problems presented by the corrosive elements of water.

In Dearborn's complete line of water conditioning products, there are treatments to eliminate scaling, sludge, carry-over, return line corrosion and other similar difficulties. Dearborn combines the proper treatment with the right control methods under technical supervision. The result: less down time and greater operating efficiency.

Dearborn Supervisory Service provides you with the three elements necessary to maintain the best in a water conditioning program—positive control, top performance effectiveness and maximum economy.

Mail the coupon for complete information.

Dearborn®

... a leader in water conditioning and corrosion control for 70 years

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PO-WT, Chicago 54, Ill.

Gentlemen: ☐ Send my copy of Dearborn Water Conditioning Program.
☐ Have a Dearborn Water Treatment Engineer call.

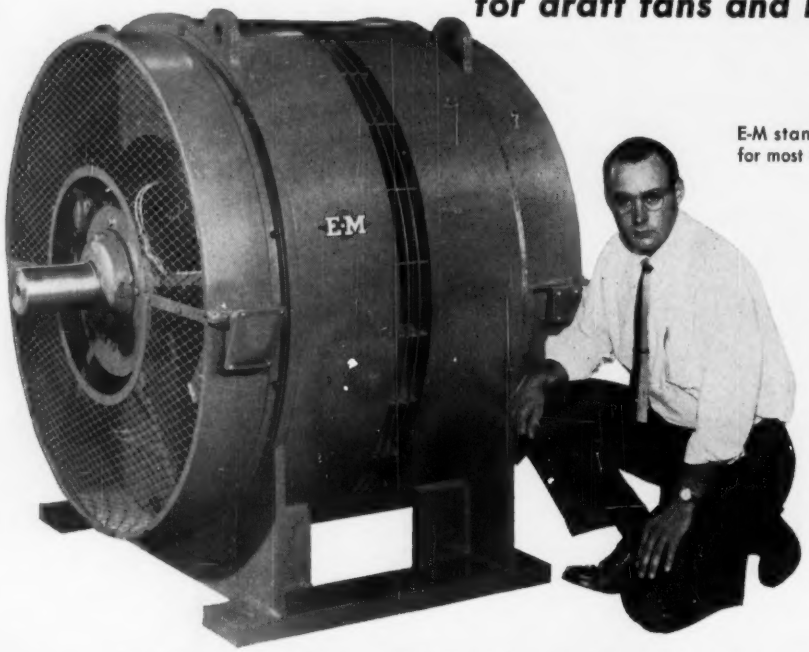
Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

This is the latest in precise, adjustable speed control for draft fans and BF pumps!



E-M standard construction for most indoor applications.

REDUCE BOILER OPERATION COSTS

with one of the four *new* E-M ADJUSTABLE SPEED MAGNETIC DRIVES

- **More power in less space**
- **Simpler installation**
- **Better, quieter cooling**
- **Lower maintenance**

E-M Magnetic Drives help you reduce costs of auxiliary drive power and maintenance. Here's how:

LOWER POWER COSTS by eliminating need for wasteful throttling of boiler feedwater pumps and draft fans. Magnetic Drives *control speed* for efficient operation of auxiliaries.

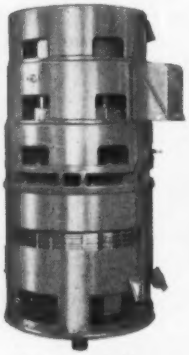
MINIMIZE FAN EROSION by operating fans at speeds to fit boiler combustion demands.

HAVE FAST RESPONSE to improve combustion and cut down thermal losses.

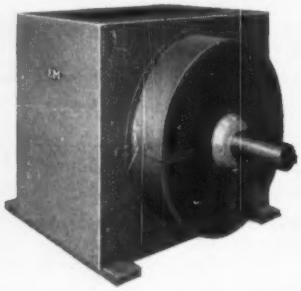
GIVE ACCURATE SPEED CONTROL. "Regutron" Control is responsive to *speed* of driven equipment regardless of changes in operating conditions. "Magnetic action" gives ±½% sensitivity. Anti-hunt and damping circuits assure stable operation.

OFFER BROAD SPEED RANGE. A large number of speed steps gives virtually stepless speed control . . . lets you select and keep exact speed.

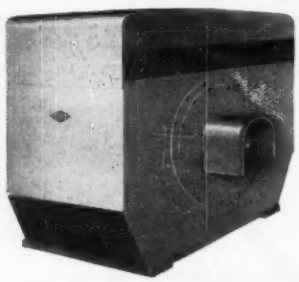
Write E-M for literature, or call your nearby E-M Field Engineer. He'll be glad to tell you first-hand all about the new developments in E-M Magnetic Drives.



Vertical E-M Magnetic Drive and Motor.



Top air discharge type for larger high speed ratings. Heat can be ducted away.



Weather-protected outdoor design. Screened intakes at feet, discharge near top.

E-M

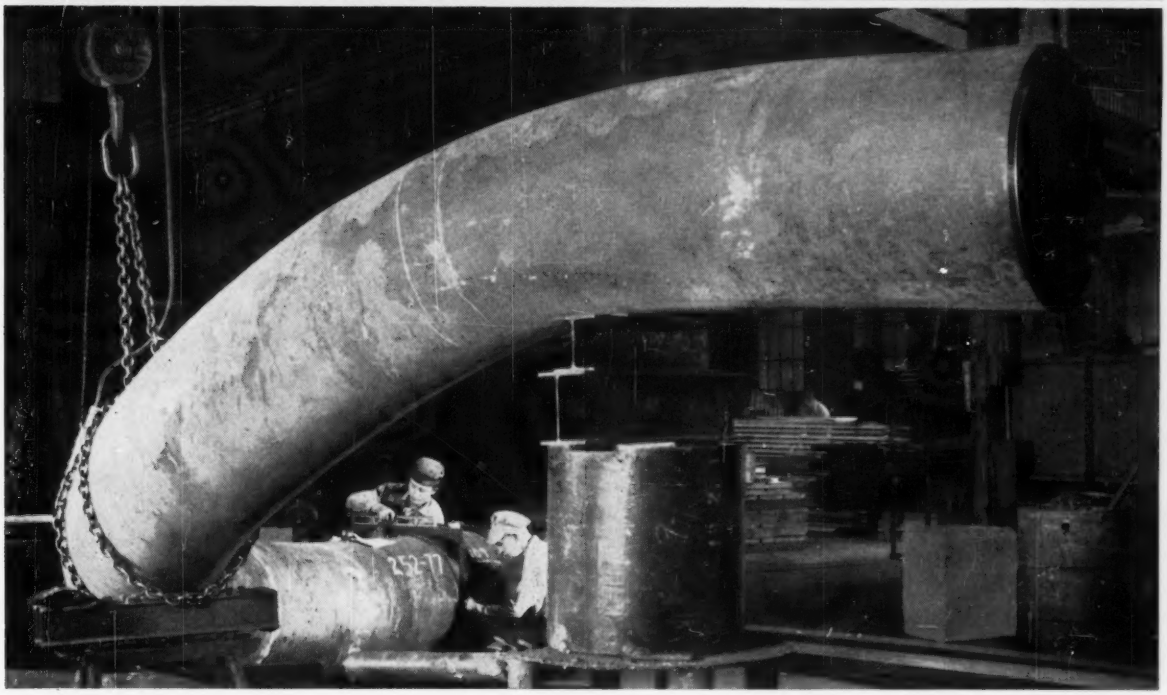
4400-TPA-2175

ELECTRIC MACHINERY MFG. COMPANY

Minneapolis 13, Minnesota

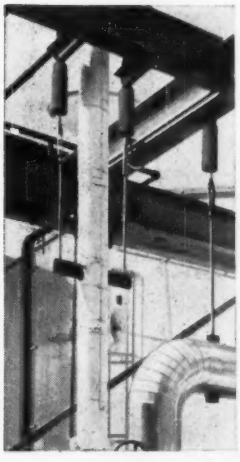
Specialists in making drives do **EXACTLY WHAT YOU WANT THEM TO**

BLAW-KNOX has what it takes—to provide these products and services



Large chrome moly pipe being readied for shipment to new generating station. Making a right angle bend followed by a 24 degree, 18 foot bend in this heavy 27½ inch chrome moly pipe required all the skill and modern facilities of the Blaw-Knox power piping shop. Before shipment, piping is heat-treated and ultrasonically tested with a radar-type device for detection of any defects.

A new Blaw-Knox "6 x 6" Flexibility Matrix Method of computing stresses in power piping systems is now available to consulting engineers, companies, and individuals responsible for the design of power piping systems. By the use of an electronic computer this method cuts calculating time from months to a day; assures full accuracy to six significant figures; and has no limitations on the complexity of the system. Write for further information about our new "6 x 6" Flexibility Matrix Method.



Two-way control over movement of piping is provided by Blaw-Knox functional spring hangers with the patented internal swivel action—shown in this modern outdoor generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. To get full information, write for Catalog No. 54.

Each year serious fire strikes one out of every seven manufacturing firms in this country. Be safe. Let a Blaw-Knox fire-protection engineer study your needs—and explain how you can pay for the system on our lease or deferred payment plan. To get more information send for Bulletin No. 2426—"Fire Can Destroy Your Business."

BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

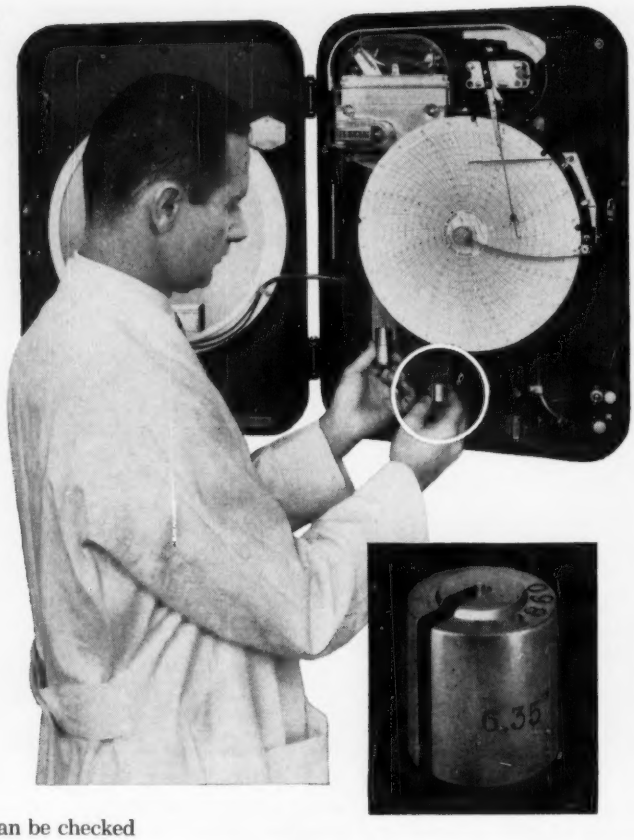
829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures
. . . complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators
. . . complete line of automatic sprinkler systems for standard and special hazards

HAGAN RING BALANCE FEATURES—NO. 3

CHECK CALIBRATION OR CHANGE RANGE IN MINUTES

without water columns—without disconnecting meter from line



TIME SAVER—This shows how easily a Ring Balance can be checked. Note there are no two-story water columns—one man is doing the job—and the meter has not been disconnected from the line. In fact, Ring Balance can be checked at full static pressure if desirable.

The check weight is factory calibrated against a micrometer type manometer, and its equivalent in inches of water column is stamped on the side. The serial number of the meter to which it belongs is also stamped on the collar. A full set of calibrated weights is supplied with each meter.

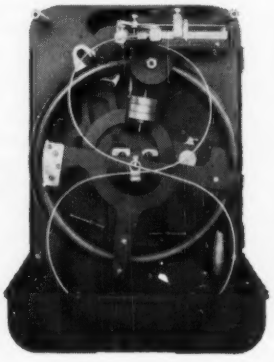
The calibration of any Hagan Ring Balance meter can be checked —in minutes—by simply hanging the appropriate weight on the check weight rod. Similarly, range change over a seven to one differential range can be done with equal speed and accuracy.

In terms of instrument technician's time, you can easily figure how much this one feature of the Ring Balance will save you. And, you don't have to take a busy pipefitter away from other work to break connections.

Ask your Hagan engineer to show you how easily range change and calibration checks can be made, using only the set of check weights supplied with each meter. Ask him, too, to explain some of these other outstanding features of the Hagan Ring Balance:

1. High sensitivity at low flows due to unique range calibration system. Full scale deflection at ½" WC.
2. Safe operation with rings rated at 2,500, 6,000, 15,000 psig. No gaskets, no stuffing boxes.
3. Sealing fluid density and level not critical. No eye-droppers.
4. Interchangeable ring assemblies for full scale ranges from 0.5" WC to 560" WC. Adjustment on any one ring over a seven to one differential range.
5. Wide range computation and/or compensation by means of built-in, easily checked mechanisms available on most models.
6. Pneumatic or electric transmission also available.

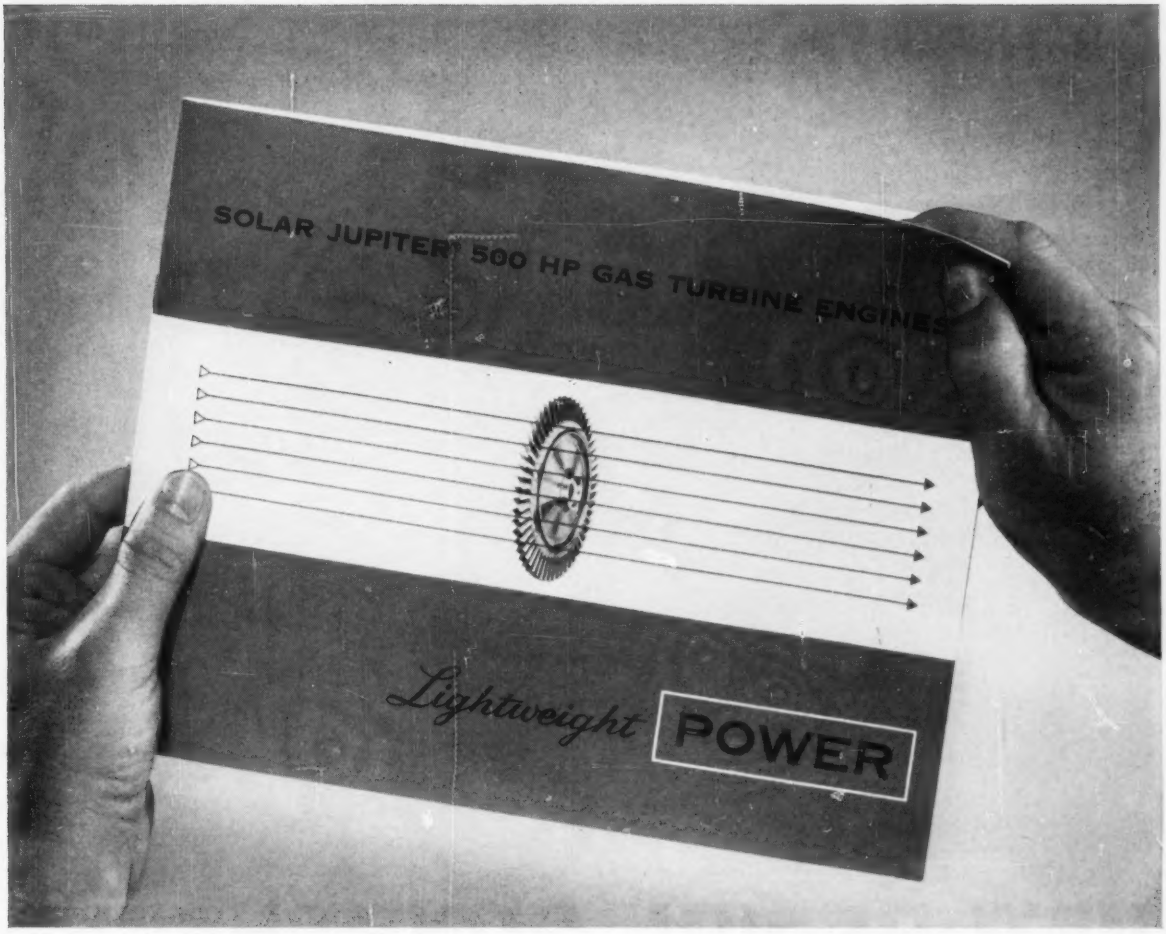
Bulletin MSP-141 describes these features and the new design of the Hagan Ring Balance meter case. ASK US FOR IT.



Rear view of Ring Balance with cover plates removed. Here the test weights are in position on the test weight rod. Note accessibility of all parts for easy adjustment.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED
OFFICES IN: MONTREAL, TORONTO, VANCOUVER, EDMONTON



Send for this important brochure!

Learn how a versatile Jupiter® gas turbine engine can help solve your power problems

SOLAR'S 500 HP JUPITER gas turbine offers a radical new power concept for forward-looking businesses. One of the simplest of all heat engines, it provides reliable power for a wide range of military and commercial applications—including boat propulsion, mechanical drive, power generation and others. New users praise its high power-to-weight ratio, its instant starting even under severe temperature extremes, its easy portability and low maintenance requirements.

Solar has prepared a colorful 24-page booklet giving full details about the Jupiter. It contains all of the information necessary to acquaint you with the many advantages of this exciting new engine—and it's yours for the asking. Learn how this power plant of the future can go to work for you—*today!* Solar Aircraft Company, San Diego 12, California. *Designers, developers and manufacturers of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

FOR NEW JUPITER BROCHURE, MAIL TO:
Dept. D-117, Solar Aircraft Company, San Diego 12, California.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____

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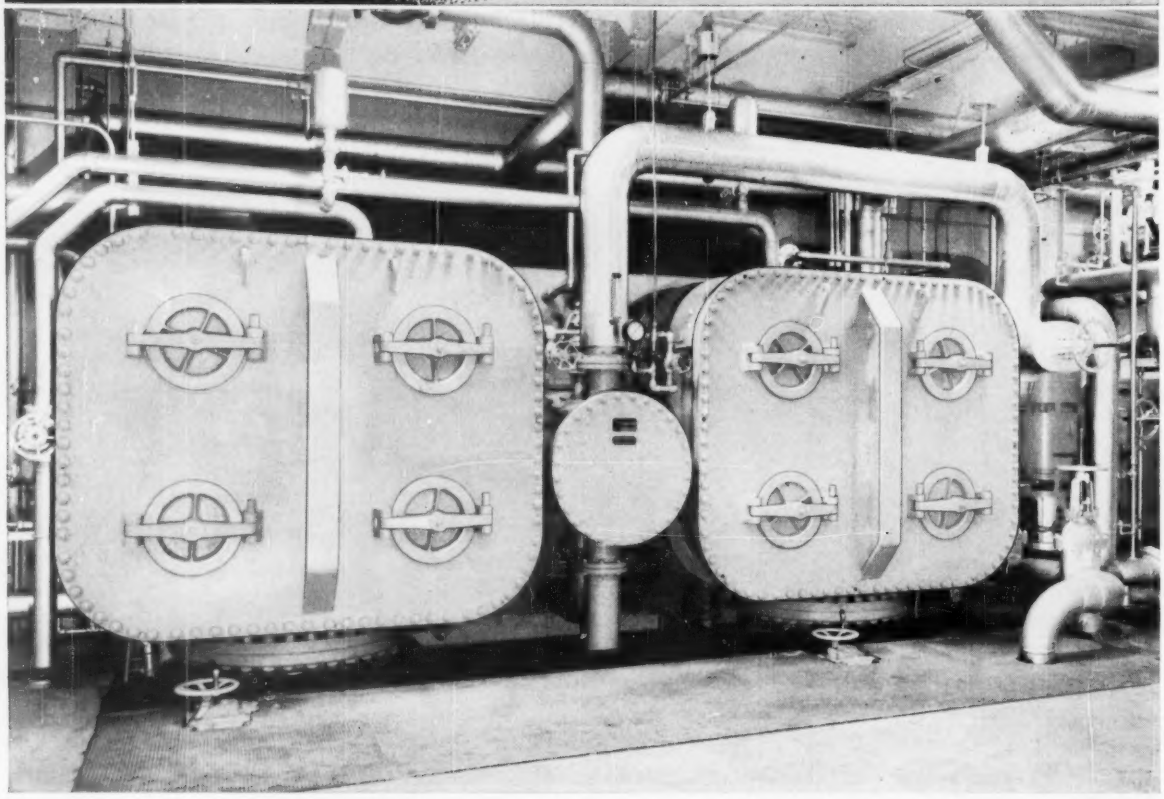

NEW-DESIGN CONDENSERS SAVE SPACE AND MONEY

Steam generation of electricity has made tremendous progress in the last 25 years because of the ever-increasing efficiency of the equipment used.

A power equipment manufacturer with many "firsts" to its credit, Yuba is continually designing, among other equipment, condensers with low head room to save much-needed space. This advancement is illustrated above in the photograph of a rectangular shape condenser for the Suwanee River Plant of the Florida Power Corp.

A low pressure heater is installed between the tube banks to further save plant space, as well as initial cost for foundation and piping. An additional design feature of Yuba condensers is a de-aerating section within the condenser shell which eliminates the main plant de-aerating heater. Maintenance and downtime costs are reduced by welding tubes into tube sheets.

For advanced condenser design, that will save space and money, consult the Yuba Heat Transfer Division, formerly the Heat Exchanger Division of The Lummus Co.

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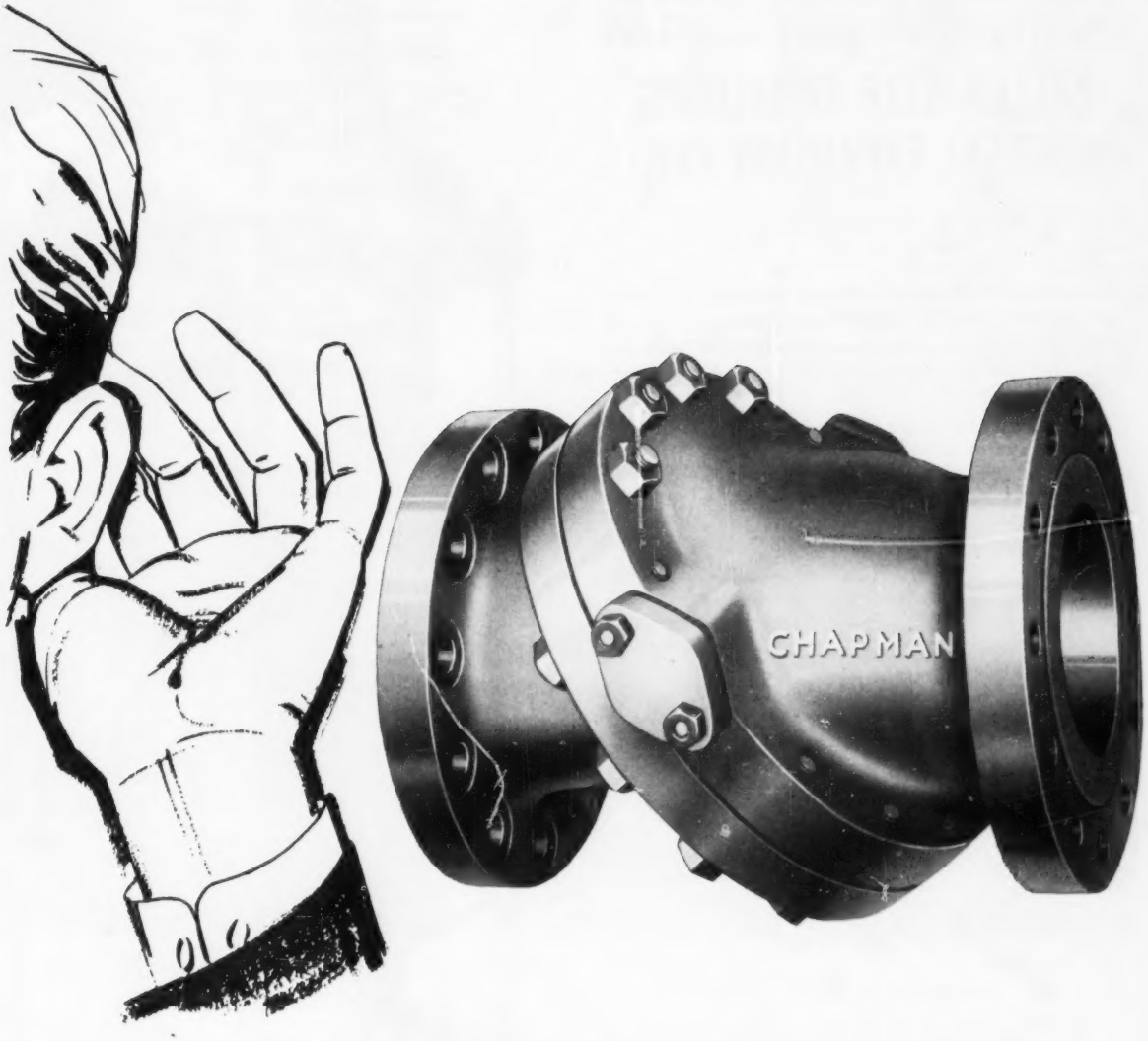

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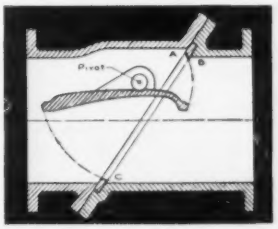

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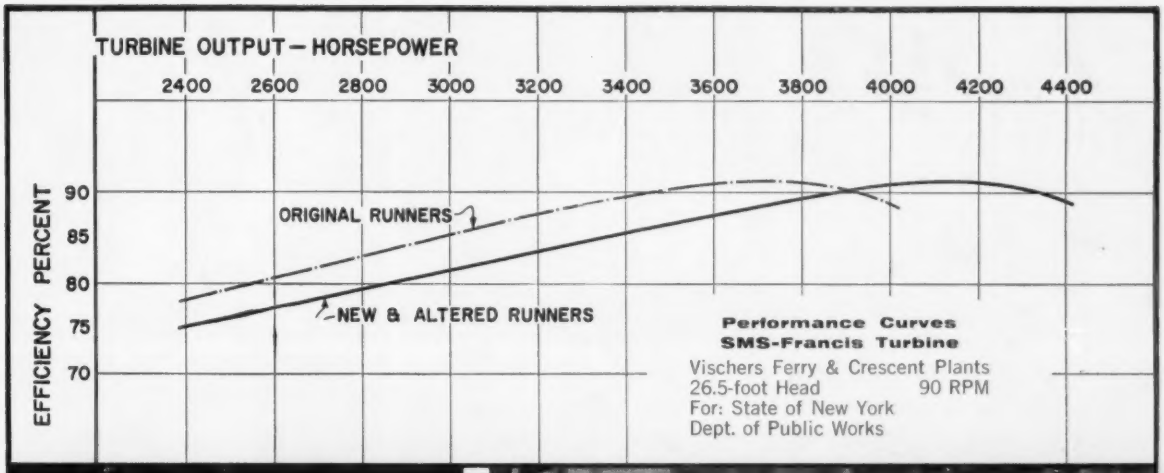
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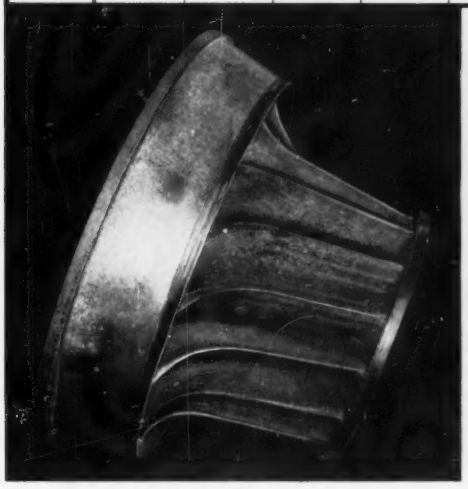
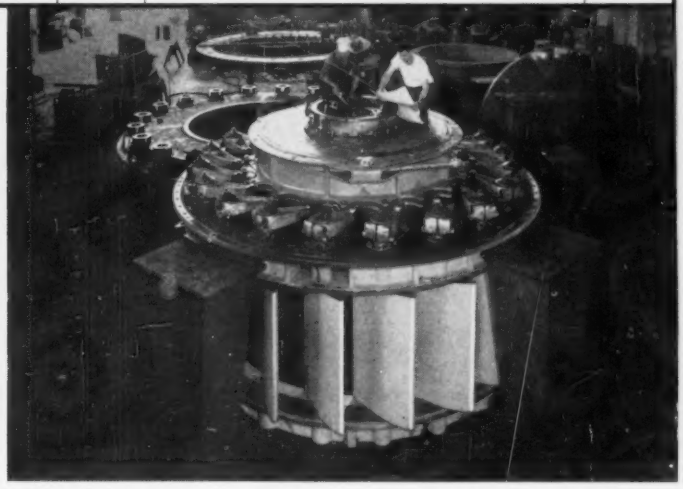


Modifed runner for Vischers Ferry unit #4. Note excellent condition of runner after long initial service.



The rebuilt distributor of Crescent unit #1 is checked during final assembly in the SMS shops.

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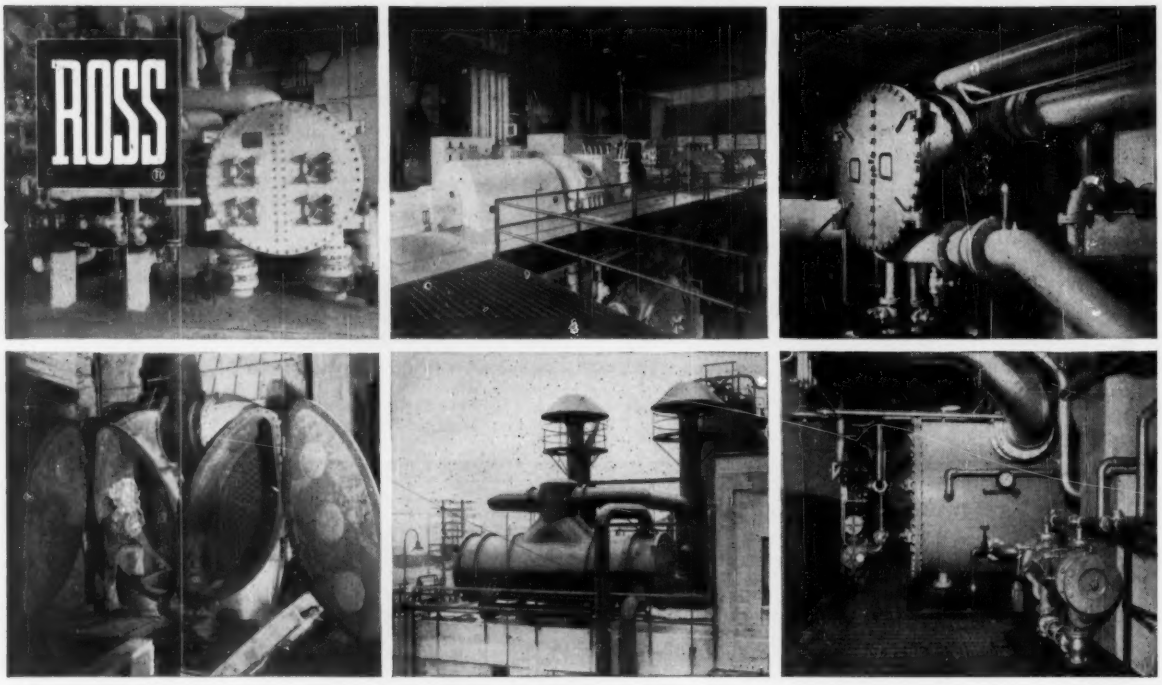

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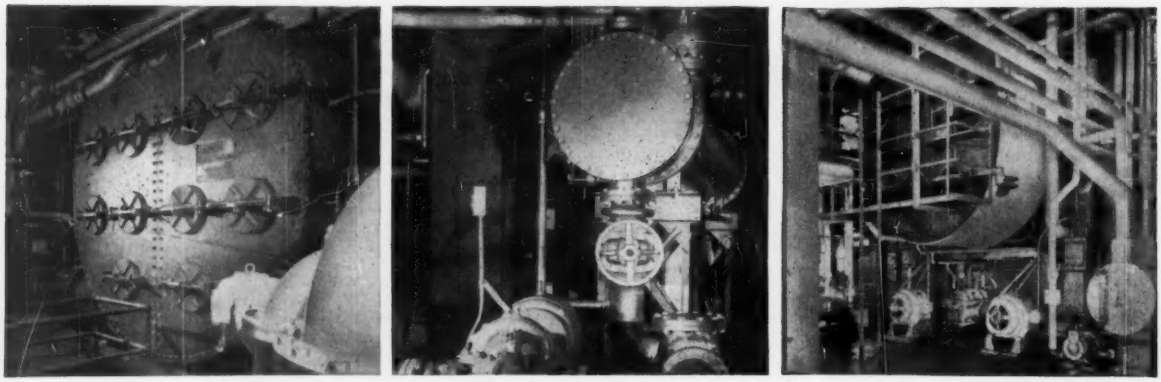

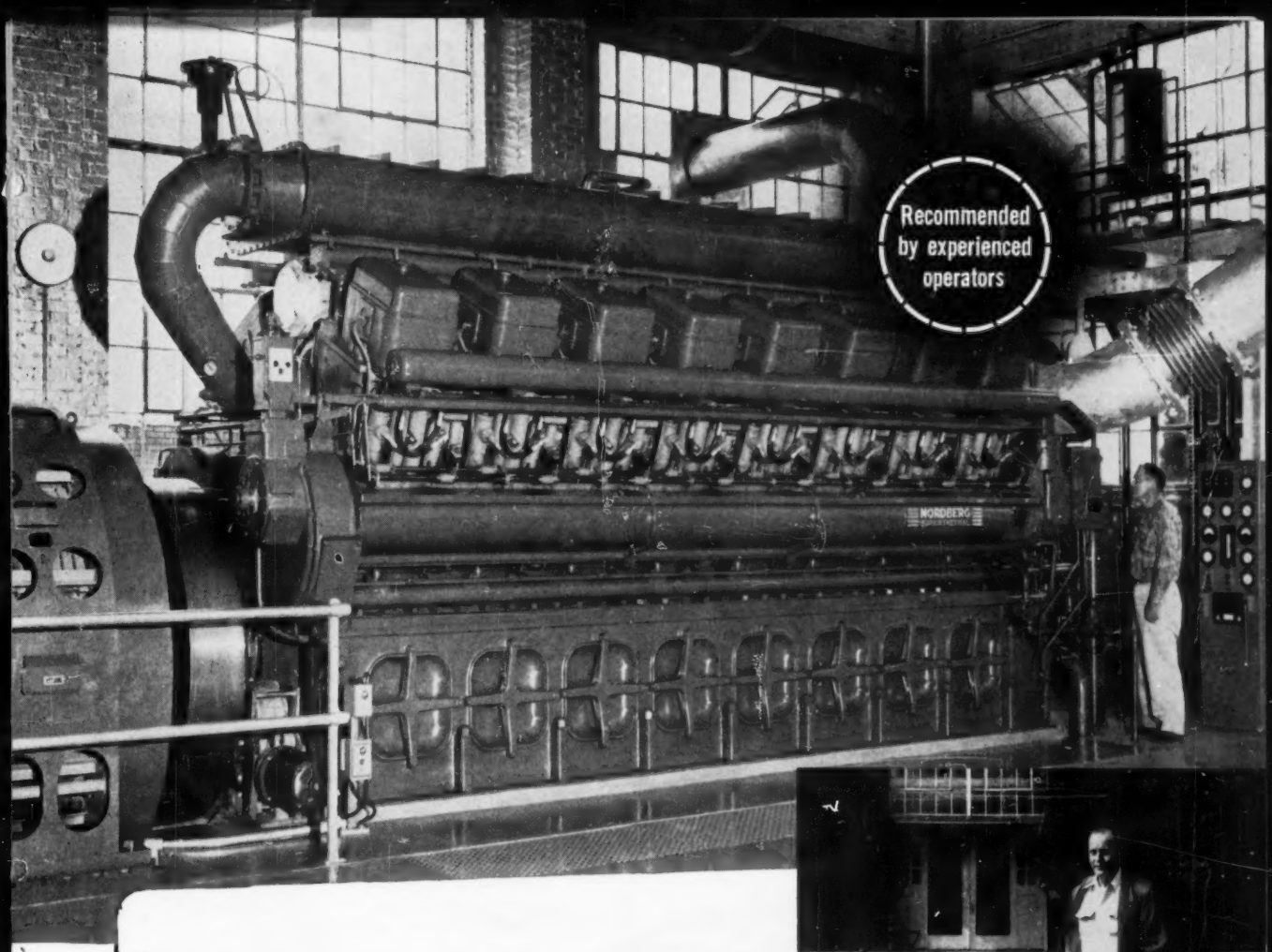

"Neodesha has now installed their sixth Nordberg engine ...all are giving a good account of themselves..."

...says Mr. Everett Powell,
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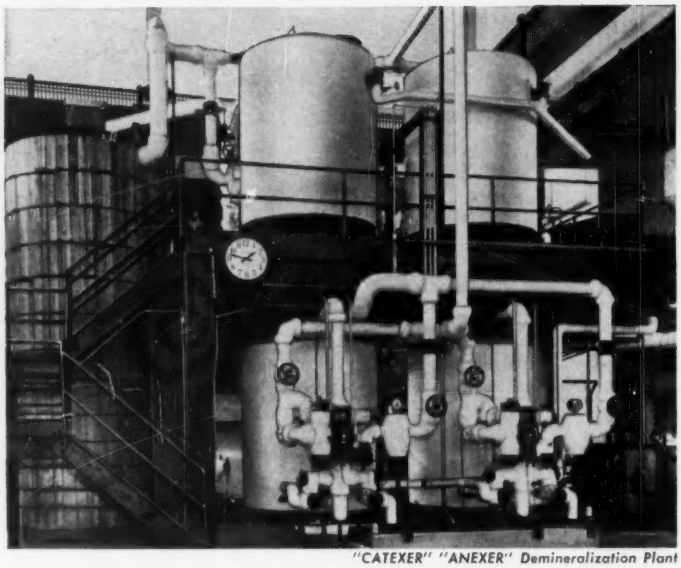

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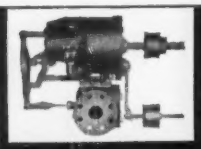

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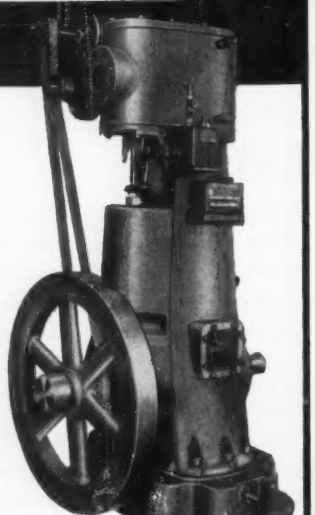

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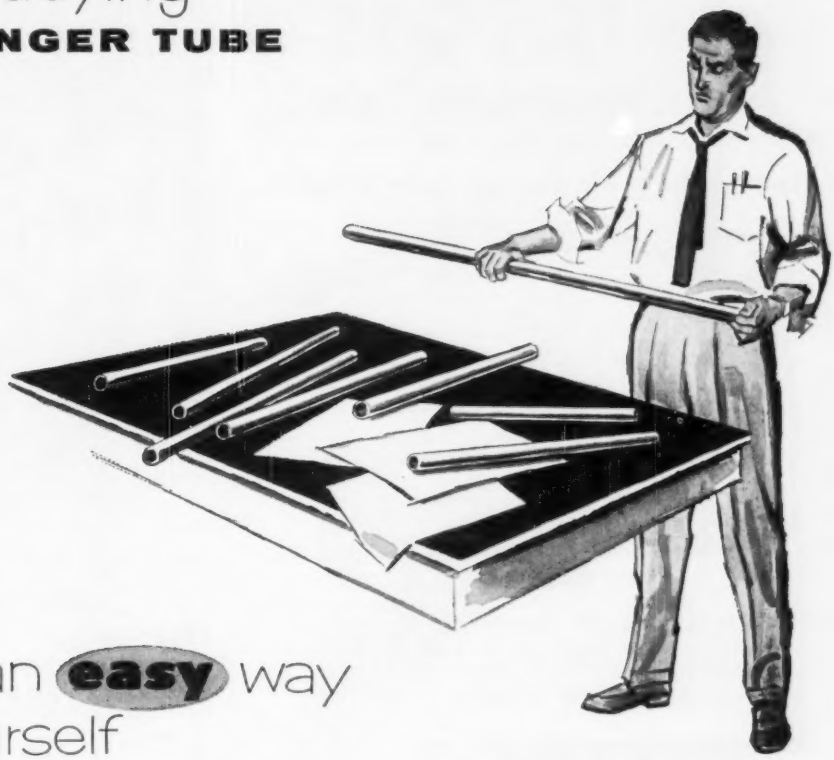

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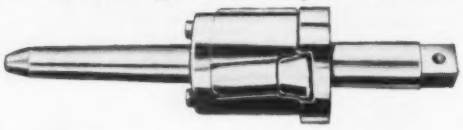

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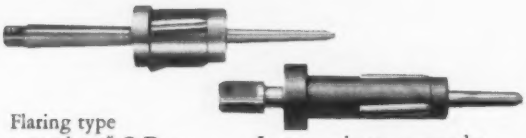

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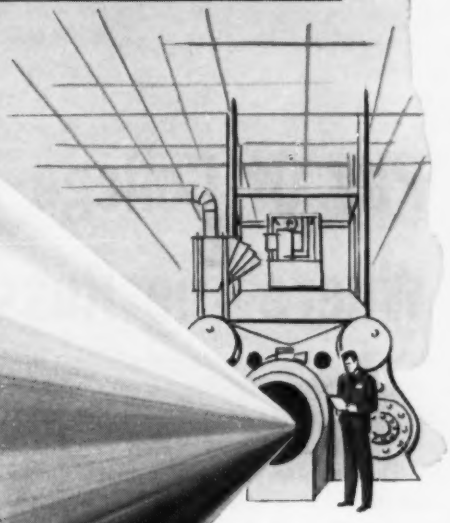

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Pay Of College Teachers... Where The Russians Are The Capitalists

This editorial deals with a simple question about college faculty salaries: Which country pays its teachers better, Russia or the United States? It's a good question, with a sadly embarrassing answer.

That American college and university teachers are underpaid is not a novel observation. But what has happened to the economic status of their profession can be put in more candid terms. **As far as financial incentives are concerned, we have virtually socialized the academic profession.** Teaching has become such a poorly paid career, with so little prospect of material reward for outstanding performance, that it simply does not attract enough highly qualified young men and women.

Ironically, the Soviet Union has deliberately and successfully used capitalist incentives to improve its educational system. Although the Russians show an utter disregard of civil liberties, they pay their teachers well and confer on them all the prestige and privileges the Soviet society can offer. Russian professors, together with party officials and scientists, have become the privileged upper class of a supposedly classless society.

Incentives To Be A Teacher

To be a college teacher requires high intellectual competence and long, sometimes costly, formal training. Aside from the appeal of academic life, what incentive does college teaching offer bright young men and women?

In the U. S., the average faculty salary is little more than the average income of industrial workers. According to the National Education Association, the average faculty salary is about $5,240. College instructors receive $4,100, associate professors $5,730 and full professors $7,100. The average income of U. S. factory workers in 1956 was $4,580.

Actually, workers in many industries — steel, automobile and petroleum, for example—earn more on the average than college teachers. And skilled workers often earn more than full professors at some of our colleges and universities.

In Russia, on the other hand, the young Soviet graduate can see that it pays — and pays very well — to choose teaching as a career. The head of a department in a Russian university can command a salary of about 6,000 rubles a month.* This is about eight times the income of the average Russian worker, who earns 750 rubles a month.

The Russian professor comes off very well in terms of what his income will buy. It has been estimated that, based on Soviet consumption patterns, 6,000 rubles a month is worth about $7,200 a year — or higher than the average professor's salary in the U. S. Of course, it is difficult to compare living standards in two countries as different as the U. S. and Russia. But particularly in the field of science — where the salaries can run to 15,000 or more rubles a month — it is clear that the Soviet professor enjoys a higher real income than that offered his American counterpart by a much more prosperous economy.

Incentives To Be A GOOD Teacher

Russia also offers much higher premiums than the U. S. to those who attain distinction in teaching. Teachers at the university level earn significantly more than teachers in high schools, and university instructors can look forward to a sharply progressive rise in earning power as they

* *Soviet Education for Science and Technology* by Alexander Korol of the M.I.T. Center for International Studies.

How Faculty Salaries Compare With Industrial Wages

(Worker's Wage In Each Country = 100)

*Sources: Center for International Studies, M.I.T.; National Education Association; McGraw-Hill Department of Economics

advance to higher positions. The spread between the income of a full professor and the lowest academic position is greater than fifteen to one. In addition, full professors can earn a healthy bonus if they are elected to membership in the Russian Academy of Sciences.

In the U. S., by contrast, full professors on the average earn less than twice as much as beginning instructors. And many college professors earn less than public school teachers in large cities. Even a full professor's pay does not compare with earnings in other professions or in positions in industry requiring similar training. The point was well summarized in a recent speech by Marion B. Folsom, Secretary of Health, Education and Welfare: "It is nothing short of a national disgrace that we are discouraging people who want to teach by offering salaries that are far below the levels justified by their training and far below the levels which others are willing to pay."

Our colleges and universities, as well as our teachers, find themselves in a serious predicament. Faced with a shortage of both funds and teachers, they cannot reward distinguished performances. Limited resources for salary increases have gone predominantly to the lower ranks, so that an adequate number of teachers could be retained. Meanwhile, potentially fine teachers are being siphoned off into better paid occupations.

The shabby treatment of our teachers threatens to undermine, not only our educational standards, but our free enterprise system itself. There is the recent example of a liberal arts college which discovered that five of its graduating seniors were being offered starting salaries higher than those paid any of their professors. It would be surprising if experiences like this did not place a strain on the enthusiasm with which these professors deal with some key aspects of American capitalism.

Also important is the role education is playing in the cold war with the Soviet Union. The Russians have made great strides in raising the quality of their education — particularly in science and engineering. Both the number and the technical calibre of their graduates are impressive, as recent Soviet achievements testify. These successes owe much to the generous economic treatment the Russians have given their teaching profession.

A Standard For Faculty Pay

Earlier editorials in this series have outlined various ways American business can help relieve the financial plight of our colleges and universities. They have suggested that private contributions to higher education should average at least $400 million a year over the next ten years if faculty salaries are to be raised to adequate levels and our colleges are to be able to meet increasing operating costs.

Another standard for raising faculty salaries proposed by an American businessman is this: "When a teacher's income gets up to a point where you will suggest to your boy that he ought to give some thought to teaching as a profession, then we may be approaching the right figure."

Russia clearly has set her teaching salaries well above the "right" figure. We are nowhere near it. What this adds up to is that the Communists — not we — have become the shrewd capitalists in the vital field of education.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

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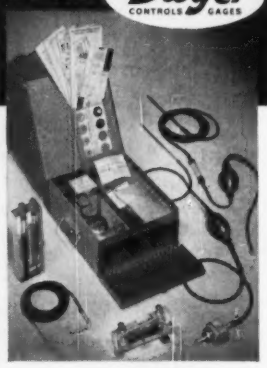

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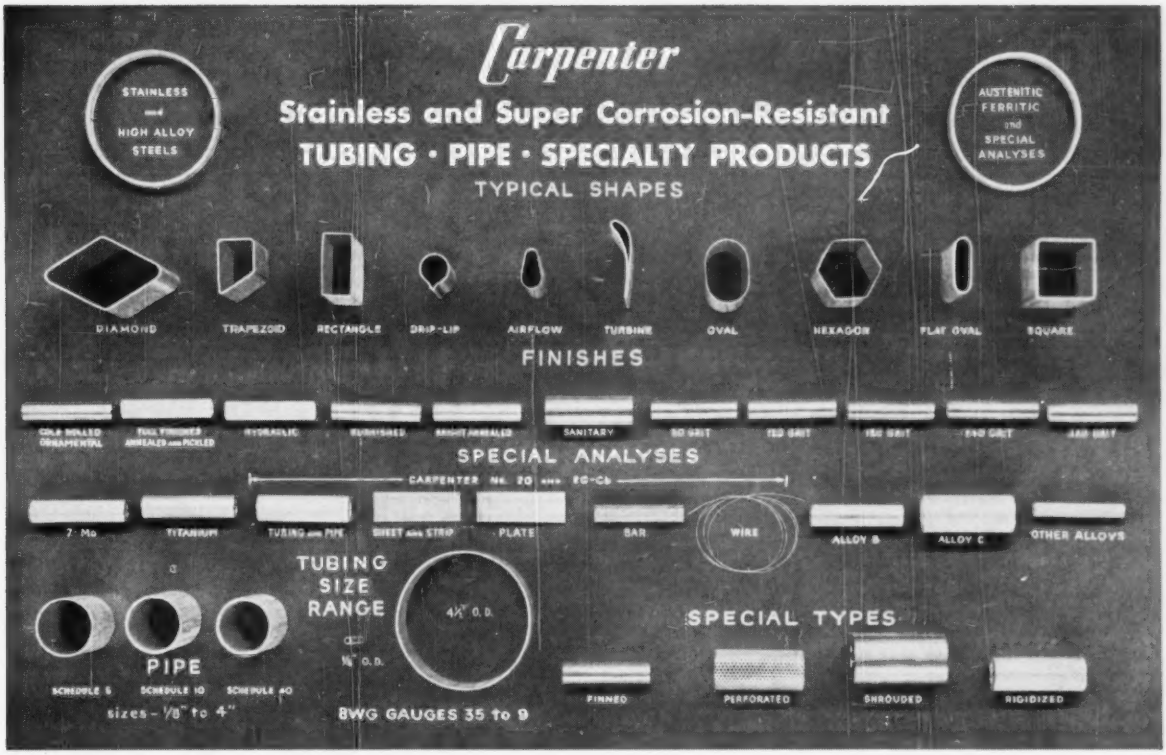

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300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	220/440	Whse.	720
125	2200	G.E.	600
100	440/220	G.E.	720

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375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

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300	2300/4000	L. Allis	FS	1800
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200	440/220	G.E.	KT	1800
200	2200	G.E.	KT	1800
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150	2200/440	G.E.	KT	600
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125	230	G.E.	CD	850

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125	G.E.	440	Sq. Ca.	250/125
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250v DC, 900 RPM, compound, dir. conn. to 150 HP Sq. Cage Motor, 3/60/440 volts complete with GE Manual Compensator and DC Panel.

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BELYEA-RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS

RE-NU-BILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES—
D.C. MOTORS WITH M.G. SETS & CONTROLS
PACKAGE DRIVES IN STOCK

1—2250 HP Elliott 300 V, 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V. 450 RPM 3 ph. 60 cy.
1—1375 H.P. G.E., MCF, 415 V, 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V. DC, 2300/4000 V. 720 RPM 3 ph 60 cycle.
1—1200 HP G.E. MPC, 600 V. D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 KP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT	6900	1187
1	1100	F.M. BB	SF806S	4800/2400	1800
1	800	Whse.	CW	550	1776
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-15	440	1778
1	500	Whse.	CW	550	350
1	350	Cr. Wh.	SIZE-718R	208/406	1765
1	350	G.E.	IM-17A	440/2200	720
1	350	Whse.	CW-1039C C-15	440	720
1	250	Cr. Wh.	MT-424Y	4000	257
1	250	G.E.	SIZE-290	2300	350
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
2	200	G.E.	IM	2200	435
1	200	G.E.	MT-557Y	2200	1750
2	200	Whse.	CW-890	2360	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-559AY	2300	3600
1	550	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
2	450	Whse.	CS-1420	2300/4150	354
1	400	G.E.	IK	2200	500
2	200	G.E.	KT-557	440	1800
2	200/150	Whse.	CS-963H	2360	1175/878
1	200	Whse.	CS-1002	2300/440	450
1	150	Whse.	CS	440	580
1	150	G.E.	IK-15A	2300	360

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
1	3500	G.E.	TS-6487P	4600/2300/4000	360
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E.	450	250/300	2300/4600
2	2100/1750	G.E.	514	250/350	2300/4600
1	2000	G.E.	514	660	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1000	G.E.	900	200	6600
2	1000	G.E.	720	600	6600/13200
1	1000	G.E.	514	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El Mhy	1200	250	2300/4600
1	300	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/3300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
1	3000	G.E.	OISC	3	32000/2300
1	1500	G.E.	PYRANOL	3 auto	4000/4200/4400
3	1000	G.E.	OISC	1	13800x460
2	750	G.E.	PUR	1	4800x35/55
3	500	KUHL	OISC	1	13600x6000
1	225	Marcus	Air	3 auto	208/220
3	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	660/11000/6600
2	2500	G.E.	35/62.5	2300/2300
1	1000	G.E.	25/56.3	4600/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	10000	Whse.	Condensing 650 lbs. 750° F.T.T. Surface Condenser Dir. Conn. Exciter.
2	3375	G.E.	650 lbs., 725° FTT. 150 lbs. G.B.P. non-condensing
1	2000	Al. Ch.	175 lbs., 5/30 lbs. G.B.P., non-condensing 3/60/480 volts.

BELYEA COMPANY INC.

43 Howell St., Jersey City 6, N. J.

GUARANTEED REBUILT POWER EQUIPMENT

HERE'S A WIDE SELECTION FROM OUR GIANT STOCK

MOTORS SLIP RING

3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

HP	MAKE	TYPE	RPM
1200	*Al-Ch.	ANY	1800
600	*G.E.	M-6345S	1800
500	G.E.	M-6345Z	1200
250	Al-Ch.	ART-626J	1800
250	*G.E.	I-M-17A-10	720
200	G.E.	I-M-16	600
200	*West.	CW-950A	514
150	Cr.-Wh.	50R	1800
150	West.	CW-874C	720
150	Al-Ch.	ANY	600
125	G.E.	I-M-15A	600
125	*G.E.	I-M-15A	600
100	G.E.	I-M-E13A-4	1800
100	G.E.	I-M-14	900
100	*G.E.	I-M	720
100	G.E.	I-M-15A	450
75	North-W	KW-50	1800
75	G.E.	MT-347-6	1200
75	G.E.	I-M-13	1200
75	G.E.	MT-356-8-75	900
75	Al-Ch.	ANY-33C	720
75	G.E.	I-M-10	720
75	G.E.	MT-352-10	720
75	G.E.	I-M-14-12	600
75	West.	CI-756A	600
60	West.	CW-FB-600C	1800
60	Al-Ch.	ARY-423C	1200
60	*G.E.	MT-356-6	1200
60	*West.	CW-762C	900
50	*G.E.	MT-536-6	1200
50	G.E.	MT-536	1200
50	West.	CW-636A	1200
50	G.E.	I-M-8	900
50	Al-Ch.	ARY-223C	900
50	G.E.	MT-346-10	720
50	G.E.	MT-546-10	720
50	West.	CW-758	720
50	Al-Ch.	ANY-26F	600
40	G.E.	I-M-11A	1800
40	G.E.	MT-336-6	1200
40	G.E.	MT-532-6	1200

MOTORS SLIP RING
Crane and hoist

3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

HP	MAKE	TYPE	RPM
100	G.E.	MTC-5548-8	900
80	G.E.	MTC-5552	600
50	G.E.	HIC	600
35	G.E.	MTC-5536	600
25	West.	CI-636-A	720
15	G.E.	ITC-5009	900
11	West.	CI-E464-A	900
10	P & H	BW-6	1800
5	North-W	WRC	1200
5	P & H	BW-6	1200
5	G.E.	MTC-5730	1800

SYNCHRONOUS MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

HP	MAKE	TYPE	PF	RPM
1420	West.	HG	0.7	900
300	G.E.	ATI-6-285M	0.8	1200
300	*Ideal	SMM	0.8	257
275	*G.E.	ATI	1.0	450
250	Al-Ch.		1.0	1200
225	Elec. Machy		1.0	360
225	G.E.	TS-6244	1.0	300
200	G.E.	TS-7359	1.0	1800
190	Elec. Machy		1.0	720
150	Al-Ch.	SYN	0.8	1200
150	*Elec. Machy		0.8	1200
150	*West.	HR	1.0	300
125	*G.E.	TS-7641	1.0	514
125	*G.E.	TS-6214	1.0	277
125	Elec. Machy			900
125	Compton		0.9	900
115	Elec. Machy		1.0	240

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

HP	MAKE	TYPE	RPM
1250	*Al-Ch.	ANX	3600
600	*G.E.	K-63458	1200
500	*G.E.	K163458	1200
350	*G.E.	KT-559A-4	1800
300	*G.E.	K-63447	1200
250	West.	CS-879-S	1800
250	G.E.	KT-559-4	1800
250	G.E.	KT-559-S	1800
250	West.	CS-8120S	1800
250	Brook	RS-28	1200
250	G.E.	I-K	600
200	*G.E.	FT-549T-2	3600
200	*G.E.	I-K-13B	1800
200	Brook	R-27	1200
200	*West.	CS-930A	900
200	*Al-Ch.		900
200	G.E.	KF-564S	720
200	*Al-Ch.	AN-37G	720
200	Al-Ch.	ARWWT	600
200	West.	CS-FR-1010	600
150	Cr-Wh.	SC-149CQ	3600
150	G.E.	I-E-13B-6	1200
150	*Al-Ch.	AN-30F1	1200
150	G.E.	I-8-FR-13	900
150	*West.	CS	600
125	*West	CS-771-1S	1800
125	West.	CS-761C	1800
125	Cr.-Wh.	5QR	1200
125	G.E.	K-538	900
125	Al-Ch.	AN	514
100	West.	CS-5078	3600
100	*West.	CS-760A	1800
100	*G.E.	FT-542Z	1800
100	G.E.	FTRP-543	1800
100	West.	CS-760D	1200
100	Al-Ch.	AW-23DS6	1200
100	G.E.	I-K-6	1200
100	G.E.	KT-553	1200
100	Al-Ch.	ARZ-826FS	1200
100	*G.E.	KT-556-8	900
75	*Al-Ch.	AR-445S	3600
75	G.E.	FT-529-2	3600
75	G.E.	FT-529Y-2	3600
75	Al-Ch.	APZ-5044	1800
75	G.E.	FT-537-4	1800
75	G.E.	KG-445	1800
75	*Al-Ch.	AR-505S	1800
75	G.E.	KT-546-S	1200
75	*G.E.	KT-542	1200
75	*West.	CS-664C	1200
75	*West.	CS-762	900
75	Al-Ch.	AR-226C	900
75	G.E.	I-10-K-14	720
75	G.E.	I-14-12	600
60	G.E.	KT-337	1800
60	Al-Ch.	APZ-504U	1200
60	G.E.	KT-343-6	1200
60	G.E.	K-505	1200
60	*G.E.	EF-505	1200
60	Al-Ch.	ART-505	1200
60	Al-Ch.	AR-823D	900
60	*West.	CS-762S	900
60	G.E.	Y-8-K	900
60	G.E.	KT-348-8	900

PLATERS

AMPS	MAKE	VOLTS
7500/3750	Elec. Prod.	6/12-220/440
7500/3750	Chandy.	12/24-220/440
6000/3000	Chandy.	12/24-220/440
6000/3000	Chandy.	8/16-220/440
5000/2500	Optimus	6/12-220/440
5000/2500	Chandy.	8/16-220/440
1500/750	Chandy.	12/24-220/440
1000/500	Chandy.	12/24-220/440

M. G. SETS

KW	MAKE	AC	DC
500	West.	440	220/110
400	Al-Ch.	2300	120/240

M. G. SETS (Cont.)

300	West.	2300	250
250	G.E.	440	250
200	G.E.	2300	250/275
200	West.	2200/4000	250
170	G.E.	220	125
150	G.E.	514	250/275
150	West.	2300/440	125/250
150	Al-Ch.	2200	250/275
125	G/E.	5000	250
125	Cr-Wh.	4150	125
100	G.E.	440	125
100	G.E.	2300	250
100	G.E.	1200	230
100	G.E.	2300/4000	250/275
100	West.	2300/4000	250/275
100	Al-Ch.	2200	250
100	Elec. Mchy.	220	125
90	G.E.	220	125
60	G.E.	220	230/250
60	G.E.	440	230/250
50	West.	220	120/125
50	Ideal	2200/550	240/250
35	West.	2300	150
30	G.E.	2200/440	125
25	West.	220	300
20	G.E.	220	250
20	Elec. Pdts.	220/440	400
20	Bogue-G.E.	220/440	125
15	Ideal	440	125

MOTORS
D.C. 230 V.

Constant Speed

HP	MAKE	TYPE	RPM
200	West.	SK-201	680
175	G.E.	KLC-11	750
100	G.E.	RC-34	2500
100	G.E.	RC-19	600
75	Roth		1800

Variable Speed

250	West.	SK-220	450/600
200	Rel.	FR-1400T	850/1200
150	G.E.	MCF	580/100
100	C.W.	CD-135-4	758/1500
100	G.E.	MPC-6	400/800
50	Al-Ch.	E-146	850/1275
35	G.E.	CD-115	500/1500
35	West.	SK-15D	350/700
30/40	G.E.	CD-123	400/1600
25/30	G.E.	RF-12	500/1600

now

Westinghouse

Single Step, Primary Resistance Type Magnetic SQUIRREL CAGE MOTOR STARTERS Three Phase, 60 Cycle, Class 11-400

Qty	HP	Volts	List Price	Our Price*
			Size 2	
1	10	220	$ 420.00	$ 147.00
3	15	220	450.00	157.00
1	20	440	484.00	169.00
1	25	440	504.00	175.00
			Size 3	
2	20	220	600.00	210.00
2	40	440	660.00	231.00
2	50	440	684.00	239.00
			Size 5	
3	60	220	2,922.00	925.00
5	75	220	2,922.00	925.00
4	100	220	2,178.00	995.00
3	125	440	2,094.00	1,075.00
9	150	440	2,094.00	1,075.00
8	200	440	2,372.00	1,175.00

*Discounts available to dealers and large users.

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CHICAGO *Electric Co.*

1320 W. CERMAK RD. CAnal 6-2900 CHICAGO 8, ILL.

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SPECIAL OFFERINGS

TURBO-GENERATORS

1—7500 KW 2400/4160 volt Condensing—400#—700° FTT. New 1949
1—3500 KW 2400/4160 volt Condensing—400#—700° FTT. New 1941
1—1000 KW—240/480 volt—130/250# Cond. Auto. Extraction—15#—New 1945
1—1000 KW 480 volts—225# Condensing—Auto. Extraction—20#
1—300 KW—480 volts—210# Condensing—Auto Extraction—40#
1—250 KW—240 volts—130#—Non-Cond. 10 12# Back pressure

TRANSFORMERS

1—500 KVA 4160/480 V. Pyranol 3 ph.
3—1667 KRH—13800/600 volts New 1948

A. LEE ELLIS CO., U.S. Machy. Bldg., 140 Federal St., Boston 10, Mass.

THE BUYERS MUST BE SATISFIED—ALWAYS

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	3000	Maloney	TCB	3	7200/6600-4160/2400
2	750	G.E.	K	1	4600-120/240
1	750	G.E.	HT	3	4150Y-208/416
3	500	West.	SL		4800/2400-240/480
1	300	Pensa.	(Askarel)	3	60-12470Y/7200-240
2	250	G.E.	H Pyranol	1	2400-4800-8320Y 120/240
2	250	West.		1	2300/4600-230/460
3	200	G.E.	H	1	7800-15600-220/440
1	150	Ehler	OA	1	4160-240/480
3	100	G.E.	H, Form W28		2400/4160-240/480
5	50	G.E.	ES	1	60-2400/4610-240/480
4	25	West.	Hypersil	1	2400/4160-120/240
3	15	West.	H Pyranol	1	6900/11950Y-120/240
1	50	Amer.	Abestol	3	4160-120/208Y

SYNCHRONOUS MOTORS

Qu	HP	Make	Speed	Type	Volts
1	100	G.E.	900	TS	2300
1	125	G.E.	600	TS	2300
1	125	F.M.	900		4800
1	150	G.E.	1800	TS	220/440
2	150	Allis-Ch.	360		2200
1	150	West.	900		220
1	300	Elec. Mch	720	TEFC	2300
1	500	West.	450	HR	440
1	1000	West.	360	Mill	2300/4150

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	690	CW	220/440
1	60	G.E.	1800	MT	220
1	60	Ideal	900	AV	220
1	75	G.E.	600	IM	440
2	100	West.	1800	T.E.F.C. B.B.	220
3	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	450	MT	2200

SQUIRREL CAGE

Qu	HP	Make	Speed	Type	Volts
1	25	G.E.	1170	405TEFC	220/440
1	50	G.E.	1200	Tri Clad	220/440
2	75	West.	1180	CS-607	440
1	100	Cent.	1750	BB	220/440
1	150	G.E.	720	KT-562	440
2	200	Cont.	1800	Exp. Proof	220/440
2	250	G.E.	1790	K.T.E.F.C.	2300
1	275	G.E.	1200	KT559BS	2200
1	300	G.E.	1800	K-4150V	new
1	400	Cont.	1200	N8068	2300

MOTOR GENERATOR SETS

Qu	K.W.	Make	Speed	DC	AC
3	60	E.M.	1200	125	220 v. Syn.
2	100	West.	1200	250	2300/4150Y Syn.
1	150	Cr. Wh.	600	125	220/440
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	1000	West.	720	600	2300/4160Y

D.C. 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
2	50	Cr. Wh.	700	CM-50H, 230V
2	75	C.W.	900	WP T.E.F.C.
1	150	C.W.	900	WP T.E.F.C.
1	250	Allis Ch.	1750	FBL 149BB

A.C. HOIST MOTORS

Qu	HP	Make	Type	Speed	Volts
1	35	G.E.	MTC	565	440
2	300	G.E.	ITC-5017	600	440

FOR POWER
J.L. HEMPHILL & CO.
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FRONT STREET, UNION 7-7272

COMPRESSORS

1902-1957

WORLD'S BEST REBUILTS

138 CFM 100 psi 7x7 Ing.—ESI
234 CFM 100 psi 9x9 Ing. ESI
268 CFM 500 psi 10—4¼x10 Ing. XOB
368 CFM 100 psi 12x10 IR-CP—Penn
399 CFM (actual) 100 psi Fuller C80-80H
420 CFM 40 psi 12x9 Ing. ES—Oil-Less
460 CFM 125 psi 12x13 Worth HB
465 CFM 100 psi 12x11 Penn 3AT
528 CFM 100 psi 14x12 IR-CP—Penn
585 CFM 100 psi 15—9¼x12 IR—XHE 3-60-4160
590 CFM 100 psi 13½—8x8 Penn DE2
676 CFM 100 psi 15—9¼x12 Ing. XRB
686 CFM 100 psi 14x13 Worth HB
868 CFM 100 psi 17—10x12 Chic. OCE 3-60-440
870 CFM 125 psi 17—10½x12 Ing. XRE 3-60-220
877 CFM 100 psi 17—10½x14 Ing. XRB
1007 CFM 100 psi 19—11x2 Chic. OCB
1060 CFM 60 psi—12-12x7 Chic YDE 3-60-4000
7950 CFM 200 psi 33—7¾x27 Ing. PRE2 4C
5748 CFM 50 psi 20—20x21 Ing. PRE1 3-60-2300
PORTABLES—60-600 CFM Rotary or reciprocating

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100 KW to 1500 KW
Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators

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18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired. *Price reasonable.*
Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
706 DONOVAN BLDG.
DETROIT 1, MICH.

FOR SALE — EXCEPTIONAL BARGAINS

Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets — Rotary Converters, Pumps, Boilers and Transformers.

UTILITIES MACHINERY CORPORATION
1965 East Sixth St., Cleveland 14, Ohio • PHONES: CHerry 1-0210 & CH 1-4070

FOR SALE

1—Slightly used Richardson Automatic Coal Scale, 200 lbs. dump, two chutes and Stock gate. Less than one-half price—write or phone.

ERVIN M. WILLIAMS
Box 410, Spartanburg, S. C.

MODERN SLOW SPEED
DIESEL ELECTRIC GENERATING SET

OFFERED AT CONSIDERABLE SAVING

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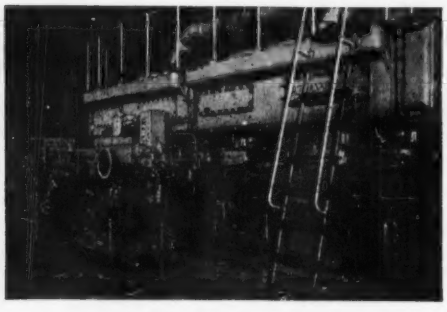
WORTHINGTON
BB5
100 KW
600 RPM
3/60/480
•
Other Sets from 20 KW to 1200 KW



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1—Worthington Jet Condenser 10x14x18.

1—Worthington Simplex Vacuum Pump.

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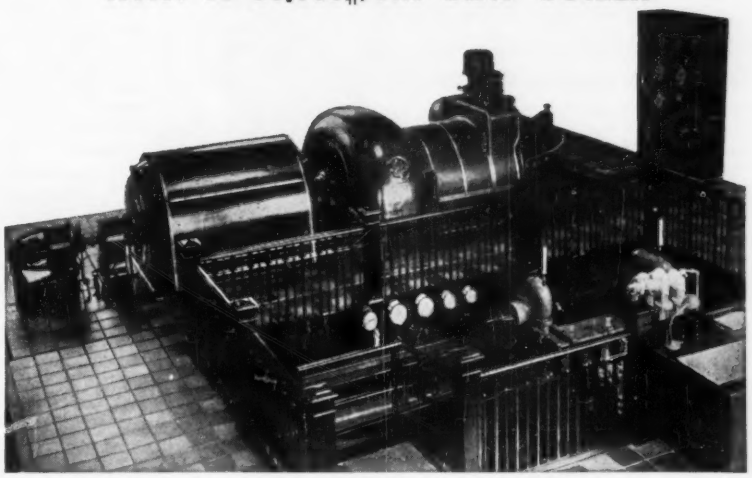

THE ABOVE 3750 KVA GENERAL ELECTRIC IS IN VERY GOOD CONDITION TURBINE #43103 GENERATOR #5406647 3/60/2300/4160V DIRECTLY CONNECTED EXCITER. COMPLETE WITH SURFACE CONDENSER, SWITCHBOARD, AND ALL AUXILIARIES.

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1—300 KVA, 3/60/4160-240 Wagner, ITE type HPE Unit Substation, Outdoor.
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
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1—Fairbanks Morse 300 HP, 300 RPM, 250 KVA F.M. 3/60/2400 generator, 7½ KW exciter.

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1500 KW Ell. Cond. 3/60/2400/4150 3600 RPM 400 PSIG 750°
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60,000 Lbs.

10 Babcock Wilcox
3 Foster Wheeler
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HP	Make	Type	Speed
400	West. B.B. Drip.	CSP-681S	1800
350	A.C. S.B. Drip	ARWW-626	3600
300	G.E. S.B. Open	IK	1800
300	A.C. S.B. Open	AR-630	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open	CS-1002	600
250	G.E. TEBB, 2300 V	K	1800
250	G.E. S.B. Open	KT	1800
250	F.M. B.B. Open	H	1800
250	G.E. S.B. Open	IK-16	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	F.M. B.B. Open	H-267	1800
200	G.E. TEBB	K	1800
200	A.C. S.B. Open	ARW-626	1800
200	G.E. S.B. Open	AT-558	1800
200	Cont. T.E.F.C. B.B.		1800
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-156	1200
200	G.E. S.B. Open	KT-562	1200
200	G.E. S.B. Open	2200V IK	1200
200	L.A. T.E.F.C. B.B.	JX-137	1200
200	G.E. S.B. Open	IK	900
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	L.A. B.B. Open	OGX-107	1800
150	G.E. TEBB	K	1800
150	West. S.B. Open 2200 V	CS	1800
150	G.E. S.B. Open	IK	1800
150	West. S.S.B. Open	CS-772C	1200
150	G.E. S.B. Open	KT-558	900
150	Cont. T.E.F.C. B.B. New		900
150	G.E. B.B. Open	KT-558	900
150	G.E. S.B. Open	IK	720
125	Howell BB Open		720
125	G.E. TEFCBB	K	3600
125	West. B.B. Open	CS-761C	1800
125	West. S.S.B. Open New	CS-607	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open 2200 V	CS-607	1800
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125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
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100	Reliance B.B. Open	AA-504	3600
100	F.M. B.B. Open	H-121D	1800
100	G.E. S.B. Open	KT-343	1800
100	A.C. S.B. Open 2200 V	ARX	1800
100	Century S.B. Open	SC-505	1800
100	G.E. S.B. Open	KT-347	1200
100	West. SSB Open	CS-607	1200
100	West. SSB Open	CS	1200
100	A.C. SB Open 2200 Volt	ARX	1800
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100	West. S.S.B. Open	CS-607	1200
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1—200 H.P. 15 lb. Cyclotherm #6 Oil
1—300 H.P. 15 lb. Superior #6 Oil
1—200 H.P. 125 lb. Cyclotherm #6 Oil
1—125 H.P. 150 lb. Cyclotherm #6 Oil
6— 90 H.P. 125 lb. Cyclotherm #2 Oil
1— 80 H.P. 250 lb. Cyclotherm #5 Oil
1— 50 H.P. 125 lb. CI Brooks #2 Oil
1— 50 H.P. 125 lb. CI Brooks Gas & Oil
1— 50 H.P. 125 lb. Cyclotherm #2 Oil
1— 60 H.P. 15 lb. Cyclotherm #5 Oil
1— 30 H.P. 200 lb. Cyclotherm #2 Oil

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1—Buda Diesel, 8 cyl., 1200 RPM, Model 8-DC, 1290, bore 5⅜", stroke 6½", circulating water cooled, w/125 KVA AC Generator, 3 ph., 60 cyc., 1200 RPM, 240 volts and exciter. Mounted on steel base.

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It's your guarantee that the equipment you buy is as perfect in workmanship as the day it left the factory.

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HP	Mfr.	Type	Volts	Speed
125	G.E.	CD-173	230	575/1150
200	G.E. dynamom.	TLC-74	250	1150/3500
170	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	850
100	Reliance	651-T	550	1000/1600
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Reliance (3)	985-T	230	450/1200
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-514	230	1150/1750
50	Gen. Elec.	CD-95	230	1800
50	Star b.b.	SQ-92	230	680
50	G.E.	CD-125	230	400/1200
50	G.E.	RF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
30	G.E.	CD-113	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	2200 AC	250 DC
200	Whse.*	220/440 AC	85 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.	2300 AC	250 DC
200	G.E.	2200/440 AC	600 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	??
100	Gen. Elec.*(2)	220/440 AC	**250 DC**
75	Gen. Elec.	220/440 AC	**250 DC**
75	G.E.	220/440 AC	**125 DC**
60	Allis Ch.	220/440 AC	250 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b. (2)	220/440 AC	**250 DC**
25	Whse.	220/440 AC	250 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	G.E.	RC	600	1150
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
125	Gen. Elec.	CD	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1200
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
50	Star b.b.	SQ	250	900
25	Whse.	SK-103	250	1750
20	Ideal	D-405	125	1150

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
500	Whse.	Slipring	2200	450
450	El. Machy.	Synch.	2300/440	400
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
400	G.E.	Slipring	2300	514
350	G.E.	Sq. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
300	G.E.	Slipring	2200/440	600
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Sq. Cage	2200/440	720
300	Whse.	Synch.	440	1200
300	G.E.	Slipring	440	450
250	L.A. TEFC	Sq. Cage	2300	900
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Whse.	Slipring	440	1200
250	G.E.	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	G.E.	Sq. Cage	440	600
175	G.E. (2)	Synch.	220/440	720
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E.	Slipring	220/440	450
150	G.E. (2)	Sq. Cage	2200/440	1800
150	Allis Ch. b.b.	Sq. Cage	2200/440	720
150	L. Allis b.b.	Sq. Cage	440	3600
125	G.E. TEFC	Sq. Cage	2200	3600
125	Ideal	Slipring	4000/2200	900
125	Allis Ch.	Sq. Cage	2200	900
100	Smith b.b. (6)	Sq. Cage	220/440	1800

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B.F.Goodrich V belt briefs—

TIPS ON THE CARE, MAINTENANCE AND SELECTION OF V BELTS FOR INDUSTRY

There's danger in replacing just one V belt at a time

When one or two belts in a set become worn or damaged, there's a big temptation to replace just the useless belts. Trouble is that the remaining belts have been stretched through use beyond their original length. The new, shorter belts have to carry most of the load. A severe shock or load strain will easily break these new belts. That's why it's always better to install a matched set of V belts rather than replace one belt at a time. Used belts can be put on a drive requiring a smaller number of belts.

This simple test can increase belt life 50% or more

Maintaining correct tension is one of the most important rules of V belt care. It will give belts at least 50% longer life—often doubles life.

Belts that are too loose will slip, causing both belt and sheave to wear out. If they sag too much, the snapping action caused when motor starts or when peak loads occur can actually break belts in two. ***To test tension,*** press down firmly on each belt. Belts that are properly tensioned will depress an amount equal to their own thickness for each 4 feet of center-to-center distance. For example, if the center-to-center distance is 8 feet, a D-section belt which is ¾ inch thick should depress twice its thickness—1½ inches.

What gives V belts their gripping power?

When a V belt fits properly into the sheave groove, it hugs the pulley side wall, produces its own grip. This high pressure contact is what gives the V belt its pulling power.

Here's why V belts made with straight sides give *extra* gripping power, transmit power better and more efficiently than other types of belts:

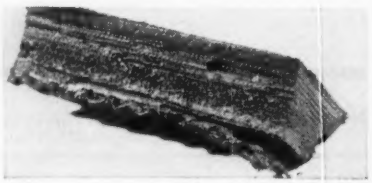
A V belt bends as it wraps around the sheave. The belt sides try to bulge, but the pulley side wall won't let them. As a result, the belt wedges itself tightly into the pulley groove.

To get an idea of how this wedging action happens, try bending a V belt outside of the pulley (as shown in the pictures at right). The bulge you see represents the *force* of this gripping action because the rubber is actually compressed by the pulley walls. This force creates all the pulling power needed for efficient service, yet without any sacrifice of belt life.

Place ruler down side of belt as shown. Ruler lies flat.

Bend the V belt, as it would be around a sheave. Now place ruler down side of belt. It no longer lies flat.

What caused this V belt failure?

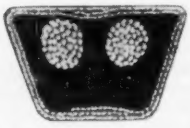


Appearance: Slip burn on belt.

Cause: Belt too loose; friction of belt against pulley groove burned rubber.

Prevention: Check tension as described in the first column. Inspect drive for overload and redesign if necessary.

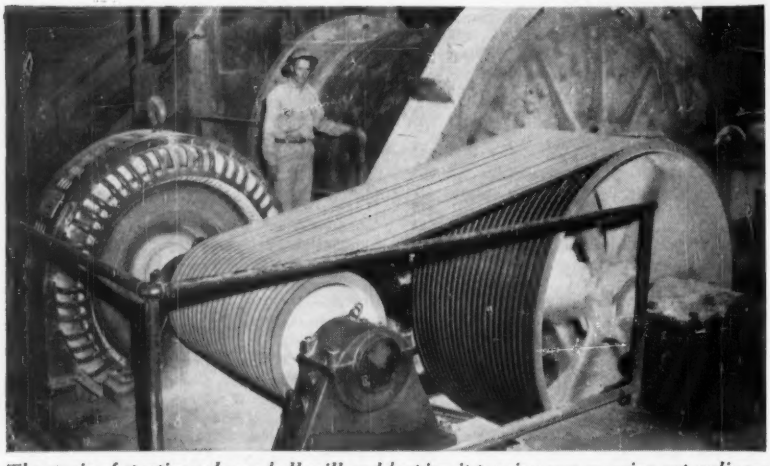
Grommet eliminates cause of 4 out of 5 V belt failures



Unlike other V belts, all the load carrying cords in B.F. Goodrich Grommet V belts are concentrated in twin grommets. These grommets are cord loops made like giant twisted cables except that they're endless. There are no splices or overlaps in this cord—no weak spots to cause premature failure. Since the section where the cords overlap in ordinary V belts is where 80% of the failures occur, this cause for failure is eliminated in B. F. Goodrich Grommet belts. As a result, Grommet belts last 20 to 50% longer, depending on the service (the more severe the service, the greater the increase over ordinary belts).

Ask a factory-trained specialist

For help in selecting V belts for any kind of service, call the man who is a specialist in V belts—your B.F.Goodrich distributor. He can help you cut costs by getting longer life from your V belt drives. *B.F.Goodrich Industrial Products Company, Dept. M-234, Akron 18, Ohio.*

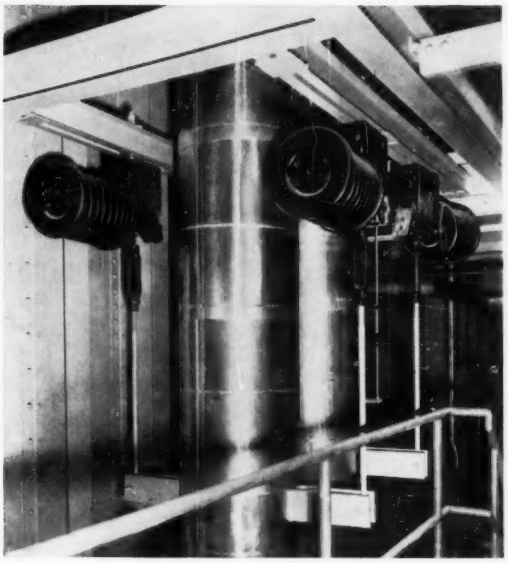


The strain of starting a heavy ball mill and keeping it turning was wearing out ordinary V belts before their time. Then Grommet V belts were tried. Because the B.F.Goodrich V belt is strong enough to pull heavy loads and take sudden jerks, the set shown lasted 6 years —longer than any other V belts used.

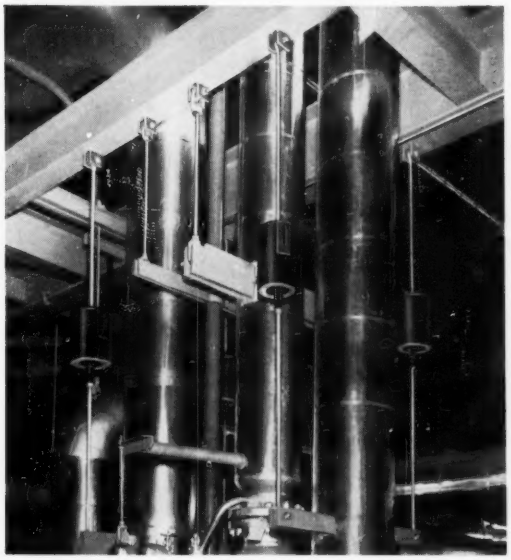
B.F.Goodrich

INDUSTRIAL PRODUCTS

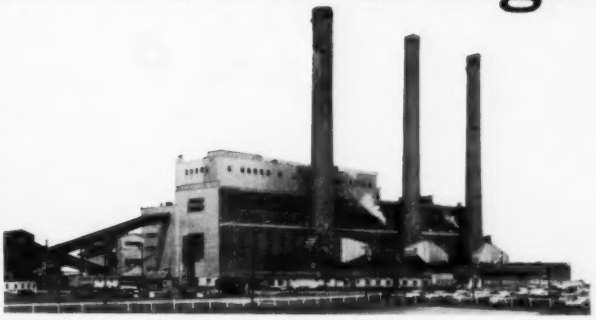
For Indianapolis Power & Light



Grinnell Model R Constant-Support Hangers on cold reheat riser piping. Constancy of support which hangers provide is mathematically perfect for all positions of travel. Note low headroom requirement. Hangers available in sizes for loads ranging from 30 lbs. to 32,260 lbs., with travels up to 12 inches.



Grinnell B-268 Pre-Engineered Spring Hangers on boiler feed piping. Patented precompression feature assures operation of spring within its proper working range. Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes. Available in 21 sizes for loads ranging from 50 lbs. to 28,200 lbs.



H. T. Pritchard Generating Station, Indianapolis Power & Light Company

Pipe Hangers by Grinnell

Six generator units have been built at H. T. Pritchard Station of Indianapolis Power and Light Company since 1947, adding up to a total station capacity of 376,000 kw. In each unit built at this station, just as in every new station constructed by this company, Grinnell Pipe Hangers and Supports have been used exclusively.*

There's good reason why major power companies like Indianapolis Power & Light look to "America's #1 Supplier of Pipe Hangers and Supports." A volume producer of pipe hangers, Grinnell backs up this advantage with an efficient coast-to-coast distribution system of warehouses and jobbers. You can depend on Grinnell for quick deliveries. In fact, even complex hanger requirements often can be met with hanger assemblies right off the shelf. This not only saves you time — but it can save you money, by cutting down on the number of special items which must be manufactured.

Benefit from expert knowledge gained during more than a century of piping experience. On your next piping job, specify Grinnell.

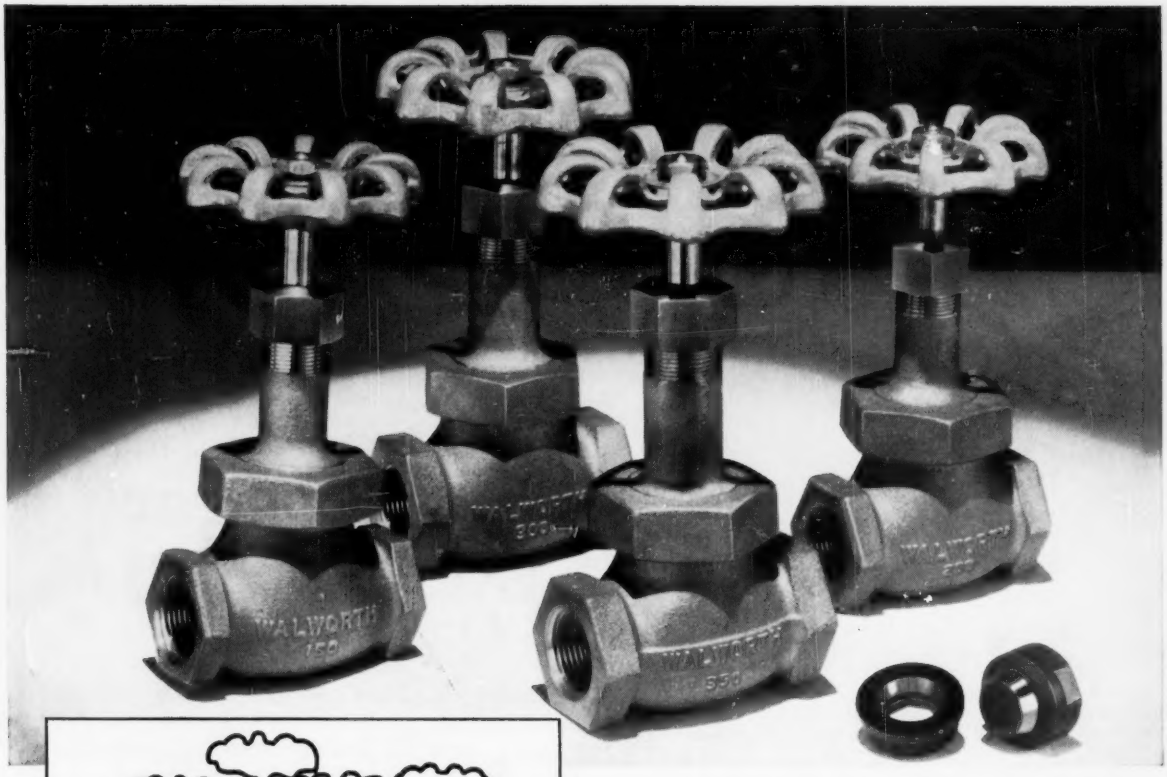
*Work done in collaboration with Gibbs & Hill, Inc., N.Y.C.

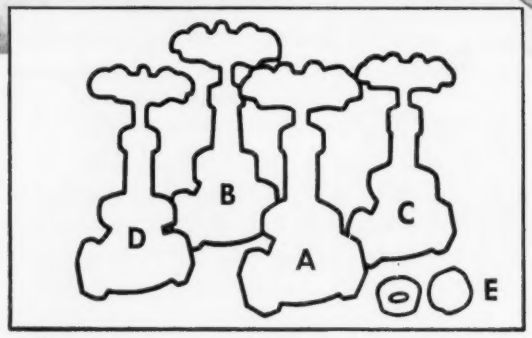
GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems





A — No. 225P.....350 WSP 550F, 1000 WOG
B — No. 260P.....300 WSP 550F, 600 WOG
C — No. 245P.....200 WSP 550F, 400 WOG
D — No. 237P.....150 WSP 500F, 300 WOG
E — "500 Brinell" Stainless Steel Plug Type Seat and Disc

Walworth offers four lines of Bronze Globe Valves with stainless steel, plug-type seats and discs. Advantages of these valves include:

• **Stainless Steel Plug-Type Seats and Discs,** heat-treated to a minimum of 500 Brinell hardness reduces wire-drawing to a minimum. Seats and Discs are machined and fitted simultaneously, assuring perfect mating.

• **Deep Stuffing Boxes with Glands** are fitted with reinforced, molded packing. Valves can be repacked under pressure when fully opened.

For Longer Bronze Valve Life . . .

"500 BRINELL" PLUG-TYPE STAINLESS STEEL SEATS AND DISCS

150 lb. 200 lb. 300 lb. 350 lb.

• **Oversize Stems,** made of high tensile strength silicon-bronze, assure long life.

• **Rugged Body Hexes,** are flat on top; do not interfere with wrench gripping body-to-bonnet union ring connection.

• **Bodies,** made of Composition M bronze (ASTM B61), have ample wall thickness to provide high safety factor.

• **Patented Handwheels** are air-cooled and designed with a "finger-fit grip." Makes turning easy even when wearing greasy gloves.

• **Identification Plates** secured by lock-washer under stem nut, show Figure Number of valves and make re-ordering sure and easy.

FOR COMPLETE INFORMATION, *SEE YOUR WALWORTH DISTRIBUTOR OR WRITE FOR ILLUSTRATED CIRCULAR*

WALWORTH

60 East 42nd Street, New York 17, New York

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